THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
DIAMOND JUBILEE
1880–1955

April
1955

MECHANICAL ENGINEERING

ASME Diamond Jubilee Semi-Annual Meeting ◆ Boston, Mass. ◆ June 19–23, 1955

Volume 77 ♦ Number 4

APRIL 1955

♦

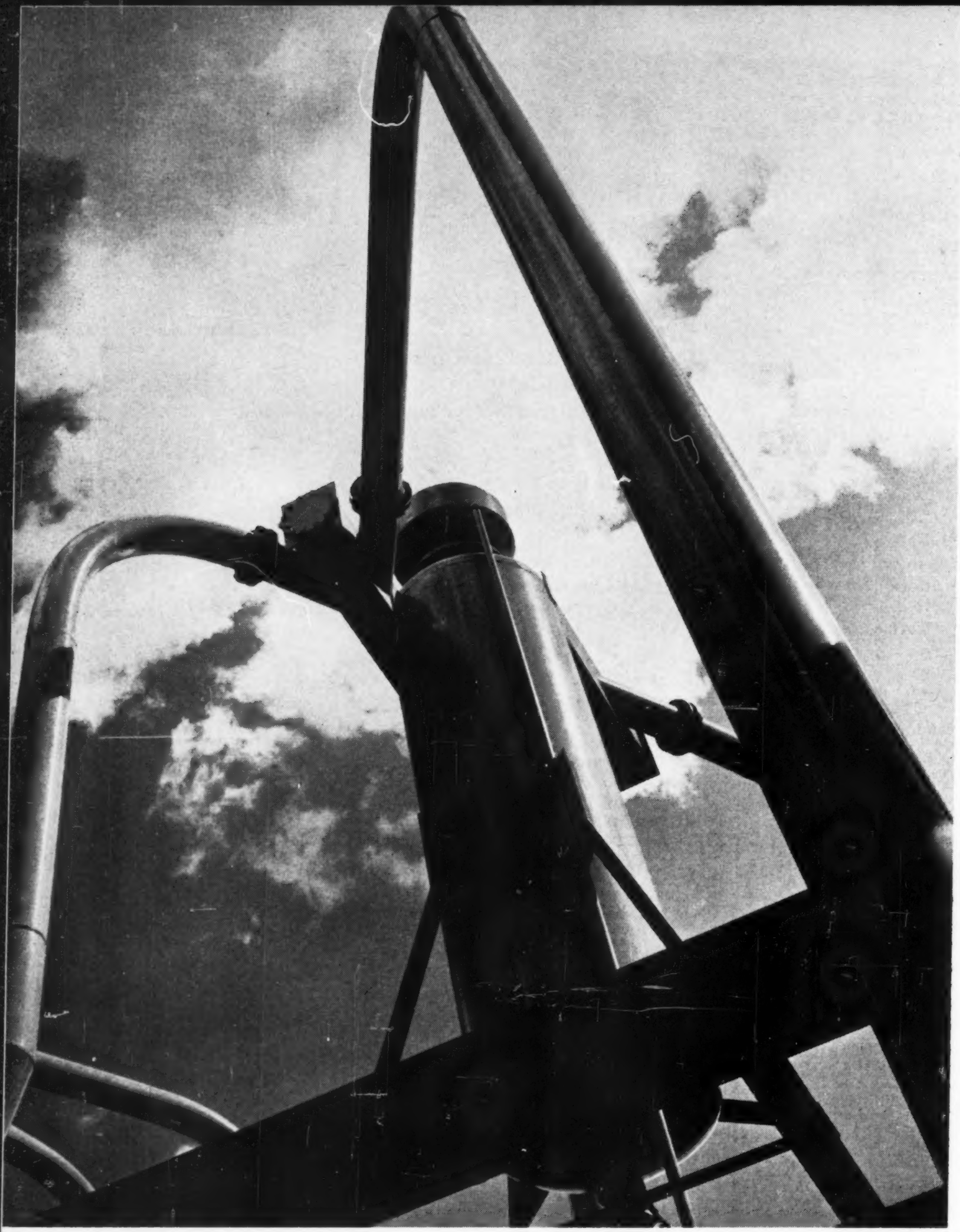
Published by

The American Society of Mechanical Engineers

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Street, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Streets, New York 18, N. Y. Cable address, "Dynamic," New York. Price to members and affiliates one year $3.50, single copy 50 cents, to nonmembers one year $7.00, single copy 75 cents. Add $1.50 for postage to all countries outside the United States, Canada, and the Pan-American Union. Changes of address must be received at Society headquarters seven weeks before they are to be effective on the mailing list. Please send old as well as new address . . . By-Laws: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Member of the Audit Bureau of Circulation.

MECHANICAL ENGINEERING is indexed by the Engineering Index, Inc.

MECHANICAL ENGINEERING



Pipes from this safety device . . .

. . . lead down to tanks in an Eastman Kodak Company chemical building in Rochester, N. Y. Lined up on the roof, they will capture liquid particles in event of a safety-valve release from kettles in the building below. The large container of the device can hold liquids in emergency. The dome separates the liquid particles from escaping air.

Editorial

MECHANICAL ENGINEERING

April, 1955, Vol. 77, No. 4 ♦ George A. Stetson, *Editor*

D. S. Jacobus

David Schenck Jacobus, who died on Feb. 11, 1955, at the age of 93, was the 35th president of The American Society of Mechanical Engineers and was elected to Honorary Membership in 1934. Born in Ridgefield, N. J., Jan. 27, 1862, he played an important part in that era of industrial and engineering progress which developed so rapidly during the last quarter of the nineteenth and first half of the twentieth centuries. As a student he was present in 1880 at the organization meeting of ASME, the 75th anniversary of which is being celebrated this month in the same assembly hall at Stevens Institute.

The Stevens Institute of Dr. Jacobus' undergraduate days was a fertile field in which the native talents of this gifted young man could take root and flourish. In an address delivered in 1928, Dr. Jacobus stated that it was "the Institute's policy to make the laboratories and work shop the center of such experimental investigations as would be of direct commercial importance to the mechanical engineering profession and to keep its professors in touch with the most advanced practice and enable them to embody in their courses of instruction the best results of applied science." The list of subjects investigated at Stevens is too long for quotation, but it bears witness to the vital atmosphere of scientific inquiry in which Dr. Jacobus spent the years from 1884 to 1906 while serving as instructor, assistant professor, and professor of experimental mechanics and engineering physics and established an international reputation as a test engineer of power-plant equipment.

Dr. Jacobus was elected a "full member" of ASME at the Erie Meeting in May, 1889. A paper of which he was a co-author with his colleague, Prof. James A. Denton, appeared on the program of that meeting and in the Transactions. At New York in the same year he presented his first paper as a member. From that time onward he was a prolific writer of papers and took an active part in technical discussions and committee work.

When Dr. Jacobus accepted the post of advisory engineer with The Babcock & Wilcox Company in 1906, his seasoned knowledge of engineering principles and practice and reputation as a skillful and accurate test engineer enhanced the prestige of a distinguished manufacturer of steam boilers. This assignment did not interfere with but rather increased the value of the lectures he continued to deliver at Stevens, the papers he presented before engineering and scientific audiences, and the services he rendered to ASME and many other engineering and scientific societies.

To many readers Dr. Jacobus was best known as a member of the ASME Boiler Code Committee. At a legislative hearing, Feb. 17 and 18, 1909, on the Rules issued by the Massachusetts Board of Boiler Rules, Dr. Jacobus was present as a representative of his company without instructions. After other boilermakers had spoken against the Rules, Dr. Jacobus, exercising that statesmanship for which he was noted, stated: "I wish to say on behalf of The Babcock & Wilcox Company that we are satisfied with the Rules and stand ready to cooperate in any movement leading to public safety." This support turned the tide in favor of the Rules and brought Dr. Jacobus to the favorable notice of John A. Stevens, first chairman of the ASME Boiler Code Committee. In 1915 Dr. Jacobus was appointed to the Committee, and he served as chairman of the Executive Committee from 1917 until his retirement in 1941.

He remained an active member of that Committee until 1948, when he was elected one of its honorary members; and even in recent years he was a frequent attendant at monthly meetings.

One remembers Dr. Jacobus as a tall slender man with an alert, intelligent, narrow face, clean shaven except for a trimmed mustache, high forehead, bald head of great cranial capacity, keen but kindly eyes, and a mouth which more often than not wore a friendly smile. As he grew older there was an increasing stoop to his shoulders as though a desire to be closer to those he outstripped in stature of mind and body, rather than age or fatigue, had made it an habitual attitude. His modest quiet manner, his thoroughness and honesty, and his clear memory commanded attention and respect. Kindliness, tact, patience to hear all points of view, and forbearance with men of more hasty temperament were characteristics of his leadership. Possessing strict integrity and sound judgment, he had learned that it is just as important to be persuasive as it is to be right. As a committee chairman he held to the policy that the ends were best served when all persons had persuaded themselves of the validity of a majority opinion and rendered no verdict that was not unanimous. His personal charm was of that rare quality which engenders warm affection with the highest respect. Generations of engineers displayed that affection and respect when they spoke of him as "Jakey" or "Doctor."

Communications—

Where Do We Go From Here?

By Vannevar Bush

President, Carnegie Institution of Washington
Washington, D. C. Honorary Member ASME

Our hope rests on the gradual spread of knowledge among men and on the assumption that with knowledge will come true wisdom. In this hope we depend on the improvement of means of communication and the gradual disappearance of obstacles to their full employment. Thus the subject of our thinking is one of crucial importance. It is one on which the progress of civilization has always rested and on which it will rest more heavily in the years to come. Any man who works to extend the power and versatility of methods and machines by which one man communicates with another, any man who struggles to bring new ways of communicating into uninhibited effect, can do so with a full conviction that he is laboring for the benefit of his fellow man.

Today we have diverse and complex means for communication, the simplest of which is communication between individuals and the principal instruments, in addition to direct speech, are the telephone, the transmitted message, and the letter. We take just pride in our telephone system. With automatic dialing it has become highly flexible, fast, and reliable. Some of us can now make calls all over the country merely by turning a dial; and more of us will soon be able to do so without human intervention and without human error except our own. There is no reason why we should not be able to see the person we converse with if we are willing to pay for the necessary channels.

The sounds we hear over the telephone bear a surprisingly close resemblance to those of the human voice, close enough in fact to satisfy any reasonable demands. What else is there to do? Well, the telephone is still, on occasion, a nuisance, breaking in on our hours of rest or work or contemplation in a most peremptory manner. There may be ways, aside from having competent secretaries, by which conversations could be carried on when both participants, rather than just one, want to talk and find it convenient to do so. Certainly there are more effective ways than those employed today of carrying on a conference of several persons. A great deal of the traveling we do, just to talk to someone, does seem rather senseless, and it becomes more senseless as the people with whom we would talk are increasingly dispersed. The only difference between a conference around a table and one over a telephone with the participants seated behind a number of separated desks, is the absence of gestures and facial expressions. There may be ways of supplying what is essential here, without unduly tying up television channels. For 90 per cent of what is transmitted in television is often sheer repetition, whereas for an effective conference one wishes merely to be able to see occasionally the facial expression of the speaker.

Letter Writing

We write one another billions of letters. This process is still extremely crude. To write the letter we talk to a stenographer or a machine, and what we say is reproduced, often none too precisely, by a girl who pushes keys on a typewriter. We can short-cut this process by talking to a machine and mailing a disk or tape to talk back on a distant machine, but this doesn't readily produce a convenient record. No doubt we could make a machine that would type when we talked into it. It would do strange things to the language, perhaps, but it might be useful. Or we could ease the problem by writing fewer letters and telephoning more, if we had a convenient way of recording conversation so that the record could be filed and consulted, and if we could get over our aversion to having such records or devise a system by which the recorders could be in use only when both parties wished them to be.

When we mail a letter, a half dozen persons have to read the address and toss it into its appropriate compartment. This is utterly archaic. It is quite possible to read addresses photoelectrically if they are in proper code and to render all sorting automatic. The great bulk of our mail could be thus handled. Incidentally, before too long, we shall have two addresses for everyone—one for mail and one for the telephone. It would be nice if these two addresses could be combined.

The Printed Word

The second principal form of communication is from one to many, or from a small group to a large audience. It is usually unidirectional, although a heckler sometimes tackles a public speaker, especially when the latter is expounding political wisdom. The greatest instrumentation here is the printed word. Much progress is being made in printing. Metal type is on the way out, although it will take some time for it to disappear com-

Delivered at the Banquet during the Founding Anniversary Meeting, New York, N. Y., Feb. 16, 1955, of The American Society of Mechanical Engineers. Slightly condensed.

pletely. We are approaching national newspapers, and magazines that are nearly current exert a profound influence on the public's understanding or perhaps at times on its misunderstanding. We can confidently expect better methods of printing and better methods of distributing what is printed.

Entertainment is a form of communication. I think that it is fortunate that entertainment and advertising have made possible the enormous growth of radio and television. Together with the press and magazines, these media are producing an informed electorate and a united public opinion throughout the country, beyond anything that was possible without them. Of course, there are and will be abuses as long as clever men try to sway multitudes for selfish purposes. But I suspect that a demagogue would have to be superhuman to put over a false act on the American people when he appears before them on their television screens at so close range that they can almost count the hairs in his eyebrows. I also suspect, although perhaps I am overoptimistic, that the very weight of advertising that is thrown at the public today is developing a healthy scepticism, and that this may in time necessitate a greater reliance on reason and less on mere repetition.

Transmitting Signals

Intermediate between the foregoing two great forms of communication is another, the transmitting of special messages or signals. I do not have in mind in this connection the telegraph message, although I think we would all welcome a technical advance in this field which would enable us to place on a man's desk a few words, more promptly, accurately, and at lower cost. The general idea of the teletype might conceivably be extended to make this possible. But I have in mind rather the transmission of messages where most of the data are already in the hands of a recipient, and all that needs to be sent is a signal or symbol to select or alert. Paul Revere and William Dawes were sent on their ride of warning by the hanging of a light in the now fallen tower of Old North Church. Our modern fire-alarm system is a good deal more effective and yet leaves much to be desired. Fire losses today are enormous and residential fires in particular cause great loss and suffering. Perhaps some of this loss might be avoided if our alarm system, however efficiently transmitted, did not depend so much on someone's seeing smoke. A more dependable system would be one which automatically called the fire department whenever there was either undue smoke or excessive heat in any part of a house. It would have to be periodically tested, of course, and provision would have to be made to alert the family as well as the authorities. It is quite possible to build such a system and there is not much doubt that it would pay.

Another type of communication of this general class is one that gives the location of things. We are approaching the time when the position of every airplane in the sky will be known centrally at all times. It would be helpful to have a similar system for the control of freight shipments and trucks. The detail involved in such systems is of the kind that can be dealt with very effectively by modern data-handling devices. It seems to me, too, that it is about time for someone to devise a good automatic system to signal when robbers hold up a bank or a store.

The progress of our civilization in peacetime depends, and has always depended, not only on our current thoughts and findings, but on the skill and facility with which we create, store, interchange, consult, and utilize the whole record of our collective past experiences. We are making enormous strides in the development of methods for creating a record of what we learn—in printed words, by photography, or on a magnetic tape. We are also making strides in developing means for the transmission of ideas from one to another or from a central point to great audiences. But in one exceedingly important phase of the whole problem we are making little progress indeed. This is the phase of finding in the record the information that we need. If the record of our experience is to serve us well, we need to be able to extract from it at will, promptly and inexpensively, any single item of current moment.

Information Lost

We are building the record at a prodigious rate. Books, magazines, technical journals, reports are being produced by the ton. The Library of Congress reported in its *Quarterly Journal of Current Acquisitions* for August, 1954, that in fields of science, technology, medicine, and agriculture it received in the fiscal year 1953 approximately 30,000 journals including 2000 new titles; 25,000 research reports; 15,000 books and monographs; 15,000 manuscripts; 10,000 pamphlets; 5000 prints, blueprints, microfilms, etc.; and 150,000 maps and charts.

Our libraries are filled to overflowing and their growth is exponential. Yet in this vast and ever-increasing store of information we still hunt for particular items by horse-and-buggy methods. As a result there is much duplication and repetition of research. We are being smothered in our own product. While we record with great care the work of thousands of able and devoted men, full of significance and timeliness to others, a large and increasing fraction of their work is, for all essential purposes, lost simply because we do not know how to find a pertinent item of information after it has become embedded in the mass.

The problem is not essentially one of techniques. It is rather one of deciding who is to do the job of clearing up the confusion and under what auspices. There are plenty of good techniques available. Recently I participated in a study of how mechanization could be applied to the problem of searching in the Patent Office, where millions of items need to be scanned for equivalents of the combinations presented in patent applications. This study showed that there are at least fifty companies active in the production of one kind or another of data-handling equipment. I have not time to review all the ingenious devices now being used for commercial purposes by banks, insurance companies, and other businesses, or for scientific computation and analysis in hundreds of fields of research. Suffice it to say that there are several ways in which items can be scanned at the rate of a thousand a second, selected in accordance with a complex code, and reproduced automatically. Photographic methods can reduce the size of a record by a factor of one hundred to one or more and re-enlarge on call with negligible loss of legibility, thus cramming the material of a thousand books into the space of a cigarette package. Digital computing devices can manipulate records in the form of numbers at the rate of a million operations a second if necessary. Magnetic tape can receive any kind of data, combine them, and reproduce

them at will; and it lends itself to ready erasure, replacement, and rearrangement. There is no lack of powerful versatile equipment, which is quite capable of rendering our stored records available in prompt, accurate, effective fashion, and at a distance if this is desired.

But to code our scientific literature or our legal documents or any other part of our mounting records and thus to place them under the control of machinery responsive to our will is a stupendous undertaking. Worse than that, it is everyone's business and the assigned responsibility of no one group in particular. There is not the slightest doubt that it would pay, in a very practical sense, to do the job no matter how seemingly great the cost. It would pay everyone and the expense should therefore be borne by everyone. Thus it is a task for Government. But is it possible for a government which cannot even mechanize its postal system to be farsighted and courageous enough to undertake a task of such complexity and such magnitude? Probably not. The methods to be adopted, moreover, are not at all clear at the moment. The whole art of data handling is improving every day, and it would be a mistake to freeze upon a single system prematurely. So it probably would not be wise to plunge in at once and undertake a comprehensive and expensive program for, to use an example, the entire bulk of scientific literature. The various possible approaches need rather to be tried out on a more modest scale. The time has most certainly arrived when special sections of the record can be subjected to mechanization with genuine benefit to those who use them.

Future Prospects

Looking forward, I am confident that we shall see further advances, most interesting ones, throughout the whole range of devices by which man communicates with his fellows. And as a result I believe we shall, as a race, if we do not commit suicide by indulging in total war, advance in knowledge and understanding and perhaps also in wisdom. I believe we shall advance in our mastery over the records we create, rendering them easier to consult by means which would now seem strange and bizarre to us, which will make obsolete much of what we now do, but which will give a new power and freedom to the creative mind and thereby open the way for another spurt forward of civilization. For civilization advances only as it acquires new experience and only as it makes its experience available and useful.

Communication is the lifeblood of democracy. An informed and intelligent electorate is our bulwark against political chaos. Education of the people is dependent on the means of communication that are available. In its simplest form, a teacher talking to a group of pupils, communication is an essential element. But in the more complicated processes by which the citizens of a democracy become informed, the problem of communication is more involved and extensive. Today we have intricate and powerful means for the interchange of thought among the entire population. On the skill and wisdom with which these means are employed depend the stability and prosperity of our Republic.

Peace Depends on Communication

Even more depends upon our progress in this regard. The fate of our civilization today depends on whether we can avoid all-out war. In these perilous days, when the threat of mass destruction hangs over us, we wish with all our hearts for peace; we would, if we could, put an end to all war. For the moment, in the maelstrom of international affairs as they exist, we are utterly dependent, for the attainment of peace, on the enhancement of our military strength and on our determined and steady diplomacy in meeting current crises. We have recently met one and done it well. But in the long run the maintenance of peace depends chiefly on communication between peoples and its effective uncoerced functioning. There is no people on earth that would wish to go to war if it understood the appalling consequences of such an act. No country can ever again win a great war in the sense of advancing its national interests by conquest; any war that brought into use the thermonuclear bomb or one of the many other possible terrifying weapons could result only in disaster to both participants, setting the clock of civilization back perhaps a thousand years and delivering the world again to barbarism and pestilence. If the peoples of the world know this, and if the people control, there will be no great wars. I know that democracies or nationalistic powers embodying some of the democratic spirit have gone to war with one another in the past. But no people, in control of their own affairs and with full knowledge of the power of modern weapons, will commit suicide. All attempts by demagogues to lead a nation to conquest will fail if the people really understand. And this is a matter of communications.

Today peoples are not everywhere in control and they do not always understand. Behind an iron curtain they are fed on lies and propaganda by a tightly organized minority, which follows the path of Imperial Russia and aims to conquer the world, by war when necessary, but preferably and more effectively by intrigue, penetration, and subversion. In a world where great sections of the population will not be ready for democracy in a generation, this aggressive minority has found devilish methods of bringing all people under its sway.

We must meet this threat with realism, patience, courage, and steadfastness. We are doing well in this country to keep our balance under stress. True, we have not been perfect; we have erred at times; and we have often been misunderstood or mistrusted by our friends. But, as a nation, we are solidly behind the Government's program as it stands in foreign relations. We shall arm and in every phase of modern weapons we shall develop strength. We will have nothing to do with preventive war; nor shall we attack even if the provocation is acute. But we will, in our strength, halt the advance of communist forces before they engulf all the hesitant peoples of the earth and leave us standing alone in a hostile world.

This is for the immediate present. For the long pull we would use every means to spread understanding among men. We cannot now penetrate the iron curtain well, but times will change. There looms ahead of us a long period of military stalemate, during which all-out war is not likely to erupt except by accident or from desperation. There may be minor wars, and there will be international contests waged by strange means falling just short of open war. There will be a period of dangerous stress, when we shall need all our resolution to maintain our sanity, to preserve our free institutions, and to avoid succumbing by imitation to the very tyranny we fear. It can end in different ways, possibly in total disaster, but possibly too, in a world from which war is banished and the primary causes of war forever removed.

Fig. 1 The Toolometer is an individual tool-programming unit which counts the number of operations a tool performs in the automatic machine and shuts down the machine at the proper count for a tool change

The Transfer Machine Opens New Production Horizons

Modern-machine developments bring automation nearer but require new management concepts of leadership

By Milton O. Cross, Jr.

President, The Cross Company, Detroit, Mich.

THE man who first thought of using two tools simultaneously instead of one—probably on a lathe carriage to cut two diameters at the same time—should have been honored in history because he started the idea of making the machine do a larger share of the work so man would have more leisure time for enjoying the fruits of his efforts.

From this beginning, we find the development of many kinds of single-station machines using multiple and combination tooling. These are the machines that simultaneously perform more than one operation on a single workpiece. Examples are multiple-slide lathes, single-spindle automatics, multiple-spindle drill presses, two-way, three-way, and four-way drilling and boring machines, multiple-spindle milling machines, and so on.

Combination tools were developed to a high degree along with single-station machines. These tools are convenient for combination drilling, multiple-diameter boring, form turning for milling operations and, of course, many others.

Contributed by the Production Engineering Division and presented at a joint session of the Production Engineering, Machine Design, and Materials Handling Divisions, and Research Committee on Metal Processing, at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Slightly condensed version.

Multiple-Station Machines

The first multiple-station machines were of the dial type and trunnion type. In these machines the work is placed in fixtures on index tables or trunnions, where it is indexed from station to station. Multiple operations are performed in each station. It is common practice in multiple-station machines to set aside one station for loading and unloading the work so the time-consuming operation can be performed simultaneously with the cutting in the other stations.

The demand for machines with more stations led to the development of multiple-station machines in which stations are stretched out in a straight line. These are called transfer machines, and are classified as the pallet type and the plain type.

Pallet-Type Machines. In pallet-type machines, the work is clamped in fixtures and the fixtures are transferred from station to station. After the operations are completed, the pallet fixtures are returned by a conveyer to the loading station where the work is unloaded and

replaced with unfinished work. Pallet machines are used where it is frequently necessary to change over from one part to another, also in single-purpose applications where the part is of an irregular shape.

Plain-Type Transfer Machines. In plain-type transfer machines, the work is placed in the loading station, and from there, it is transferred from station to station. At the end of the line it is ejected. Each piece of work is located individually and clamped in each station.

Theoretically, transfer machines offer limitless possibilities for combining operations. Machines with automatic positioning devices, cleaning, inspection, and assembly operation are not uncommon today. Despite the fact that there is no theoretical limit to the number of operations that can be combined into one "Transfermatic," there is a very definite practical limit.

Practical Limits of Transfer Machines

The practical limit is down time for changing tools. In explanation, consider the case of a multiple-station machine employing 120 tools that need changing every 4 hr. If the tool-change time is 2 min per tool, then the total time to change all tools is 240 min or 4 hr. In other words, the machine will produce for 4 hr then be down 4 hr for tool changing. If the number of tools is increased to 240, the down time doubles; if the number is increased to 360, the down time triples, and so on. From this explanation we can deduce that down time increases in some proportion to the number of tools in the machine. Such conditions, of course, are intolerable and yet they are quite common in many machines that are being used today. This does not mean that we have reached the limit of automation. For as the limitation of the single-station machine led to the development of the dial-type machine, and the dial led to the transfer, the present limitation of the transfer machine will lead to the solution of the down-time problem.

Automatic Tool Programming

The problem will not be solved, as it has been in the past, by a new type of machine, but rather by automatic-tool programming and the development of new automatic work-handling devices. Tool programming may be defined as the scheduling of tool operation from the time the tool is put to work in the machine until it is removed for resharpening. Most tool programming today is under operator control; i.e., the operator places the tool in the machine and keeps a mental account of its progress and removes it when he thinks it is dull. In larger machines, tool programming is nonexistent; tools are put to work and forgotten until they are broken from overuse.

The need for automatic tool programming is quite apparent when we stop to think that tools, which were once under close observation in single-station machines, are now farremoved from any immediate personal attention in transfer machines.

An individual tool-programming unit, the Toolometer, is shown in Fig. 1. It is a mechanical memory device that counts the number of operations a tool performs while it is working in the machine. After the tool completes its schedule of operations, the Toolometer shuts down the machine for a change.

Individual tool programming in itself does not reduce down time, but provides the basic programming unit that can be used to keep tool-changing down time within specified limits. Transfermatics can be designed and programmed to operate with as little as five per cent down time, regardless of the number of tools in use.

How the Toolometer Works

A detailed analysis is made of the time required per shift to change each tool. The operations are then grouped and the line is divided into sections, depending on the position of the part and the total time required per shift to change the tools in each section.

In operation, the attendant inserts the work in Station 1 of Section 1 and initiates each cycle. From there on, the parts are handled automatically. The Toolometers keep account of the individual-tool operations. When it is time to change tools, for example in Section 2, the Toolometers shut down this section, but all other sections keep operating. The parts coming out of Section 1 are banked up in front of Section 2, and parts, that have been previously banked ahead of Section 3, are fed into the line at this point. After the tools have been changed and the Toolometers reset, Section 2 is returned to automatic operation in sequence with the rest of the line. By shutting down only one section of the line at a time, down time for tool changing does not accumulate. This has been described recently as "sectionized" automation.

The foregoing is one example of how automatic programming promotes automation, and it immediately points up the need for a new kind of work-handling device. The reference, of course, is to an automatic work-banking unit between each section to eliminate the manual handling of parts while the tools are being changed. Also, a similar device at the beginning of the line will displace the operator. Thus this line could be made to operate without any direct labor, whatsoever. Manpower requirements would consist of one stock handler and two tool-setup men.

Automatic Gaging

Automatic gaging, Fig. 2, has long been a feature of transfer machinery. However, additional testing and inspection systems are emerging and hold great promise for automation of quality control. Cylinder blocks are being pressure-tested for leaks while in process through a transfer machine. If a leak exists, the casting is automatically marked in a predetermined location with yellow paint and continues through the machine for completion of all subsequent operations. There is no loss of production. At the end of the line, a photoelectric cell picks up the yellow paint and shunts the work onto another conveyer which leads to the salvage department.

Controlling quality where salvage isn't practical is an entirely different problem. Transfer machines for processing such work usually include combination gaging and ejection systems at critical locations, where defective work is automatically ejected from the machine. There is no loss of production, however, because partially processed work is automatically injected into the machine as a replacement for the defective part.

Other quality-control operations which have been integrated in transfer machines are volumetric tests, weighing and balancing, hardness, straightness, size, and concentricity.

It will soon become difficult to distinguish between the transfer machine and the production line. Advances in

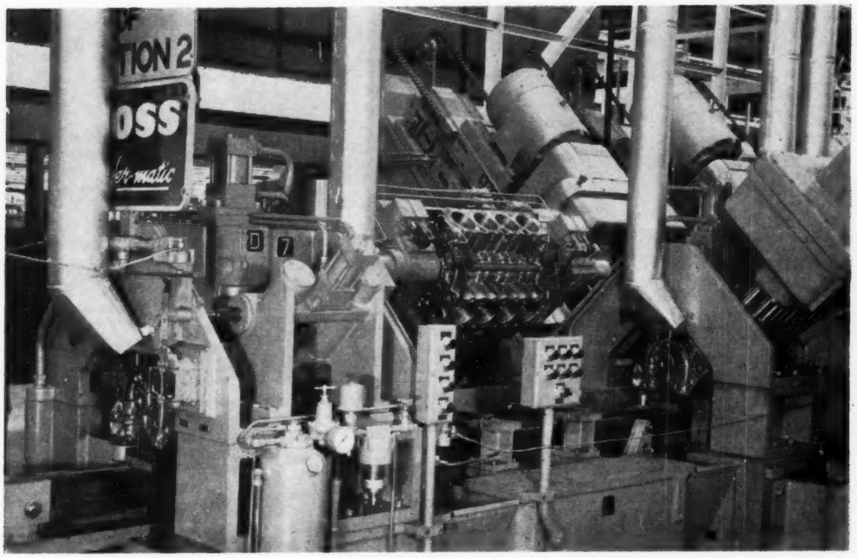


Fig. 2 Automatic gaging machine—in this case cylinder blocks are being pressure-tested for leaks while in process through the transfer machine

automation and additional integration will lead to subassembly and then final assembly operations.

New Kind of Management Needed

This new technology will demand understanding of the principles of production and their consistent application on the part of all managers. It will require the entire business to be seen, understood, and managed, as an integrated process. This process requires a maximum of stability and predictability; hence it must be based on careful objectives and long-range decisions. On the other hand, it also requires great ability of managers at all levels to make decisions that adapt the process to new circumstances, changes in environment and disturbances, and yet maintain it as a going process.

This new technology demands, above all, that management create markets—there must be consuming ability parallel with productive ability. Management no longer can look upon selling as an attempt to find a buyer—it must focus continuously and systematically on creating mass purchasing power and mass purchasing habits.

This new technology requires an organized and systematic approach to innovation, always with the basic theme of management by objectives that reflect long-term goals.

The successful manager of the new technology will make employment more predictable and vastly more stable. A broad upgrading of labor is under way—the unskilled must be made into a highly trained maintenance man, the skilled tradesman into a technician. The worker is becoming a more expensive resource, a capital investment of the business rather than a current cost. His performance has a much greater impact on the performance of the whole business.

Responsibilities of the New Manager

The new manager must acquit himself in several ways:

1 He must manage by objectives.

2 He must take more risks and for longer periods.

3 He must master all steps in the decision-making process.

4 He must build a closely knit management team with common objectives.

5 He must be able to communicate information fast and clearly.

6 He must see the business as a whole.

7 He must relate his product and industry to economic, political, and social developments on a world-wide scale and integrate those trends into his own decisions.

This is a large order—perhaps larger than we have any right to expect. Still the job must be done so we might ask: How? The job of managing the new technology is being and will continue to be done with the aid of two tools:

1 Simplification by method and system. That which has been done by rule of thumb or intuition is being reduced to concepts and principles and then converted to method and system.

2 Advanced management education. The man who acquires functional skills and knows only business or engineering subjects is not ready to be a manager. All he has been prepared for is to get his first job. It is becoming quite apparent that advanced management training isn't very helpful until a man has acquired actual experience in the work that his advanced studies are going to organize, elucidate, and focus.

Yet these things alone will not enable the new manager to accomplish his tasks. The more successful he is, the greater is the impact of his actions and decisions. The impact of his decisions on the business requires that the good of the enterprise be put above his own self-interest. The impact of his decisions on the people in the organization is so great that he must have genuine principles and stick to them rather than accede to expediency. The impact of his decisions on the economy is so great that the public welfare requires that he behave responsibly.

A manager of the new technology must root his actions and decisions in the bedrock of principle; he must lead not only through knowledge, competence, and skill, but also through vision, courage, responsibility, and integrity.

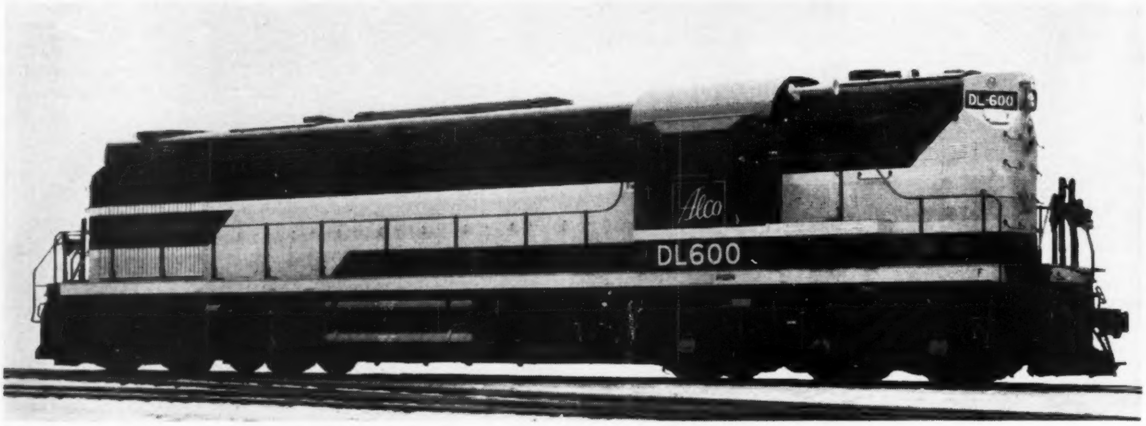


Fig. 1 Alco 2250-hp C-C general-purpose diesel-electric locomotive

Progress in
Railway Mechanical Engineering —1953-1954

As of August 1, 1954, the U. S. A. Class I railroad locomotive inventory presented the aspect shown in Table 1.

Table 1 Locomotive Inventory of Class I Railroads of the United States

	Diesel	Steam	Electric	Gas turbine	Total
Units owned or leased..	23498	9813	695	25	34031
Units stored serviceable	68	2940	19	0	3027
Units awaiting repair..	759	1081	105	0	1945

Report of Committee RR-6 Survey: Chairman, T. F. Perkinson; members, F. A. Benger, R. M. Coultas, C. Kerr, Jr., and F. L. Murphy.
Contributed by the Railroad Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of The American Society of Mechanical Engineers.

Note: The survey covers the period (approximately), September 1, 1953, to September 1, 1954.

For the first time in well over a hundred years the number of steam locomotives in service on American railroads has dropped below the 10,000 mark, and of these some 30 per cent were stored serviceable as of August 1, 1954. Only one Class I railroad still continues to operate its services exclusively with steam motive power, while several roads during the past year joined the ranks of the "100 per cent dieselized."

Steam locomotives, however, still play an important part in railroad operations in other countries and Canadian and European builders—chiefly English and German—continue to build this type of power for use in their own countries as well as in overseas operations.

The necessity of furnishing faster transportation is pointing up the desirability of higher freight-train speeds, and since this means high head-end horsepower, it is inevitable that greater horsepower must be provided

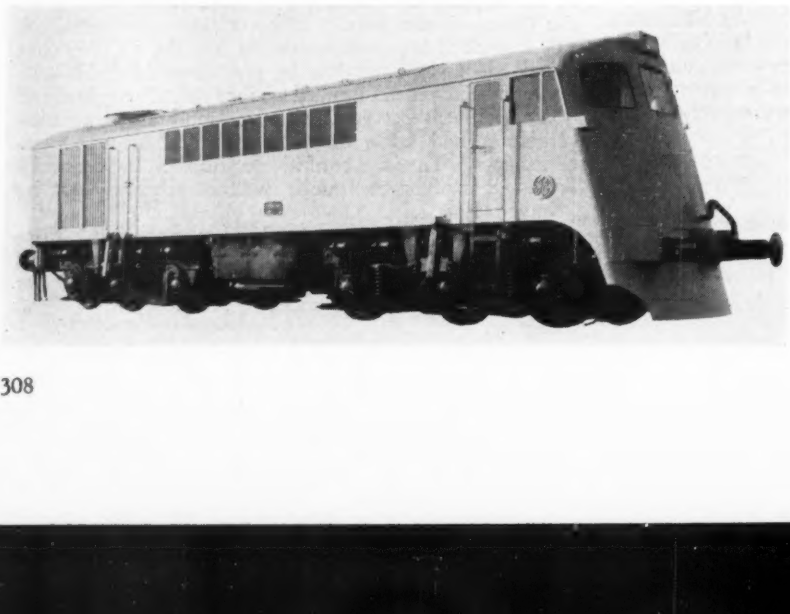


Fig. 2 Six-motored 1400-hp diesel-electric built by General Electric for use in South America

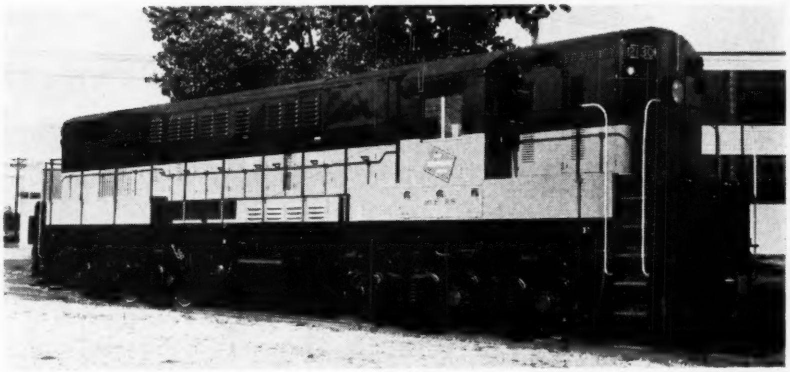


Fig. 3 1600-hp Fairbanks-Morse general-purpose diesel-electric road switcher

Fig. 4 Narrow-gage 800-hp diesel-electric for White Pass and Yukon Railroad

in single motive-power units if first costs and maintenance charges are to be minimized further.

Trend to Greater Horsepower

The trend to greater horsepower per diesel unit was exemplified by the increase in installed horsepower in the entire line of Electro-Motive road units, by the introduction of a 2250-hp all-purpose unit by American Locomotive, and by the acceptance of the Fairbanks-Morse 2400-hp "Trainmaster" (1)[1] all-purpose unit by an increasing number of railroads. While the horsepower per unit has been increasing at a modest rate, the horsepower per ton on drivers appears to have shown relatively little improvement, and the power/weight ratio of the diesel locomotive still lags far behind that found in the superseded steam locomotive, in the electric locomotive, and to a lesser extent, in the gas-turbine locomotive. Multiple-unit operating compensates for this deficiency to some extent, but greater horsepower per ton on drivers continues to present a challenge to the builders, and a hope for improved performance and lower operating costs for the railroads.

With less reluctance to employ higher-speed engines, German builders have succeeded in producing road units with upward of 20 hp per ton, while the new Maybach 1600-bhp engine is projected for twin installation in a single C-C locomotive unit (with hydraulic drive) within a total weight of 132 tons with a resultant power/weight ratio of close to 23—some 50 per cent greater than in commercially available units in the United States.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Developments Here and Abroad

The German builders are continuing the trend (as reported last year) toward the use of hydromechanical and hydraulic drives in preference to the electric drive extensively employed in the United States, and descriptions of several units employing the nonelectric drive are included elsewhere in the current survey. The use of nonelectric drives in other than small power units has made no significant progress in the United States during the past year.

Notable among the diesel locomotives of foreign manufacture, particularly those of English origin, is the presence of several designs in which idling wheels are used to hold the individual axle loading at or below permissible maximums applicable to the services for which the locomotives are intended. Apparently the desire for relatively high horsepower per unit for narrow-gage, restricted axle-loading applications, and the use of relatively low-speed engines (which seem to be all that are available from English engine builders) compel the resort to idle axles to meet the axle-loading restrictions.

The gas turbine, as a prime mover in large-powered units, continues to promise significant competition,

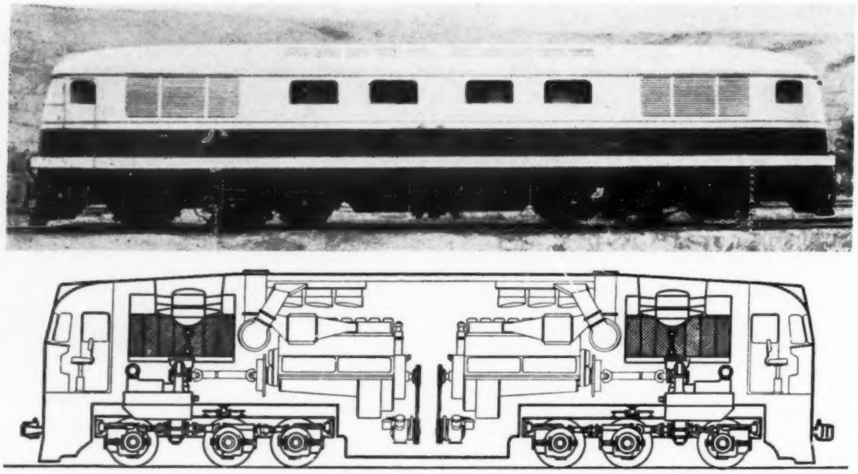


Fig. 5 1900-hp meter-gage diesel-mechanical locomotive with hydromechanical drive built in Germany for service in Brazil

Table 2 Diesel Locomotives Manufactured in the United States

Item No.	1	2	3	4	5	6	7	8	9
Builder—mechanical	ALCO	EMD	EMD	EMD	EMD	EMD	GE	GE	F-M
Builder—electrical	GE	EMD	EMD	EMD	EMD	EMD	GE	GE	W
Owner	Various	Various	Various	Various	Various	Various	Argentina	WP&Y	Various
Service	All	All	All	F&P	Pass.	Switch	F&P	F&P	All
Wheel arrangement	C-C	C-C	B-B	B-B	A1A-A1A	B-B	C-C	C-C	C-C
Engine data:									
Engines per cab	1	1	1	1	2	1	1	1	1
Hp rating per engine	2250	1750	1750	1750	1200	900	1400	800	1600
No. of cylinders	16	16	16	16	12	8	12	8	8 (OP)
Bore and stroke, in.	$9 \times 10\frac{1}{2}$	$8\frac{1}{2} \times 10$	$8\frac{1}{2} \times 10$	$8\frac{1}{2} \times 10$	$8\frac{1}{2} \times 10$	$8\frac{1}{2} \times 10$	$9 \times 10\frac{1}{2}$	$9 \times 10\frac{1}{2}$	$8\frac{1}{8} \times 10$
Engine speed, rpm	1000	835	835	835	800	835	1000	1000	850
Cycles	4	2	2	2	2	2	4	4	2
Supercharging	Yes	No	No	No	No	No	Yes	Yes	No
Manufacturer	ALCO	EMD	EMD	EMD	EMD	EMD	ALCO	ALCO	F-M
Weight on drivers, lb	325000–420000	300000–360000	240000–248000	226000–248000	216520	230000	230000	167400	298000–375000
Total locomotive weight, lb	325000–420000	300000–360000	240000–248000	226000–248000	324800	230000	230000	167400	298000–375000
Fuel capacity, gal	1350	1200	800	1200	1200	600	600	540	1200
Driving-wheel diameter, in.	40	40	40	40	36	40	40	34	40
Type of transmission	Elec.	Elec.	Elec.	Elec.	Elec.	Elec.	Elec.	Elec.	Elec.
Track gage, in.	$56\frac{1}{2}$	$56\frac{1}{2}$	$56\frac{1}{2}$	$56\frac{1}{2}$	$56\frac{1}{2}$	$56\frac{1}{2}$	66	36	$56\frac{1}{2}$
Maximum permissible speed, mph	65–80	55–89	55–89	55–102	85–117	65	75	40	65–80
Fig. no.	1	—	—	—	—	—	2	4	3

ALCO—American Locomotive Company.
EMD—Electro-Motive Division of General Motors Corporation.
GE—General Electric Company (U. S. A.).
W—Westinghouse Electric Corporation.
F-M—Fairbanks, Morse & Company.

albeit somewhat special in nature, to the diesel engine in areas where heavy fuel oil is available at costs of the order of half or less than prevail for diesel fuels. The Union Pacific Railroad is operating a fleet of 25 4500-hp gas turbine-electric units in fast-freight services with results competitive with multiunit diesel-electric operation in the same class of service. The newer design of this class of power is described in greater detail elsewhere in this report.

While it would appear that the logical application for the gas turbine to railroad motive power would be found in the large-power sizes, nevertheless the U. S. Army Transportation Corps is experimenting with a 300-hp switcher equipped with two turbines and with hydromechanical drive.

Nuclear energy, as it concerns railroad motive power, received notable attention during the past year. A feasibility study (2) of the application of a nuclear reactor as the prime power source in a locomotive received considerable attention in the technical press and among railroad mechanical engineers. The danger of radiation effects and the difficulty of practical shielding, coupled with the probability of area contamination and jeopardy to public health in the event of wrecks, appear to be formidable problems that must be resolved before the atomic-powered locomotive becomes a practical reality.

Railroad Electrification

In so far as the United States is concerned, railroad electrification continues to give way to the diesel-electric, in that the past year saw the abandonment of two short main-line electrifications—both special-purpose installations originally made to meet peculiar local

conditions. The 600-volt Michigan Central Detroit River Tunnel electrification, installed in 1910, was superseded by a tunnel-ventilating system and "through" diesel operation. The Cleveland Union Terminal 3000-volt 17-mile terminal electrification, inaugurated in 1930, was abandoned in favor of through-diesel operation, and the 3000-volt locomotives are in process of being re-equipped for 600-volt operation in the Grand Central Terminal (New York) area of the New York Central.

Interest in railroad electrification, particularly in Europe, continues with the ever-present problem of "which system in preferable" still unresolved. The International Railway Congress (3), investigating the basic characteristics of the several so-called "standard" systems now in use throughout the world, reports, in summarizing its findings:

1 The widely differing conditions which exist between countries make it impossible to place any great reliance on a direct comparison of the costs of their respective systems.

2 As regards the comparison of first costs between different systems, the variation is not only very great as between different countries but is affected to a certain extent by the diversity in size and type of the respective systems.

3 The information received regarding maintenance and operating costs has not permitted a conclusion about the effect of the system in use on these costs. This is probably because the size, type, and age of the installations, particularly of the tractive units, which affect the maintenance cost very considerably, are so variable as to prevent an effective comparison being made.

4 A great reduction in the first cost of the fixed equipment such as is often possible under favorable conditions for the standard-frequency single-phase a-c system will affect favorably the possibility of electrifying lines which would not justify electrification on the other systems. This is a big factor in favor of the system, but a more accurate assessment of this advantage could be made if a common formula were devised for determining more realistic fixed charges for different items of equipment.

5 How far this system could supersede other systems for the electrification of lines in which the cost of fixed installations is of less importance because of the greater number of the tractive units required, is still uncertain.

6 There seems to be insufficient information at present to confirm any definite superiority of any of the four main systems in all respects which would permit any one to be preferred over the other under conditions at present obtaining.

7 The evidence at present available suggests that it is unlikely that in the foreseeable future one system will prove to be the best for all railways having regard to their very diverse characteristics.

8 In any case, such superiority, wherever it exists, is not likely to be sufficient to justify the cost of replacing an existing system of the other three types considered with the one having only a marginal advantage.

9 On most lines the choice between systems can be made only by detailed comparative estimates, taking all the special factors of the lines concerned into account.

A new world speed record for vehicles on rails was set early in 1954 by an electric locomotive hauling a three-car test train on the French National Railways. A sustained speed of 150.9 mph was reached in the tests.

Fig. 6 Experimental 1-C + C-1 diesel-electric passenger locomotive rated 1880 hp for British Railways

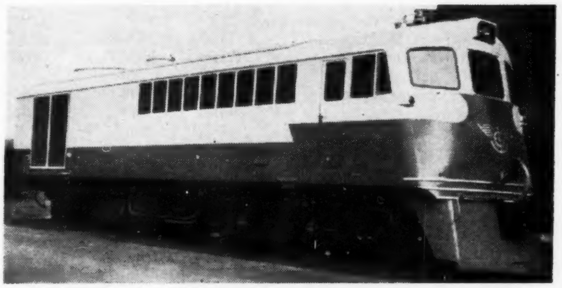


Fig. 7 1600-hp diesel-electric for Belgian Congo with Alco engines and GE designed electrical equipment

Fig. 8 Belgian-built 1600-hp unit for narrow gage under Baldwin-Westinghouse license

Fig. 9 1500-hp New Zealand Railways diesel-electric equipped with guiding trucks

In addition to setting a new locomotive speed record, the French National Railways report another record—for individual electric-locomotive mileage turned in during a single month. During one month in 1953 a 2-D-2 electric locomotive eleven years old, which had accumulated

Table 3 Diesel Locomotives

Item No.	1	2	3	4	5	6	7	8
Builder—mechanical	MFE	BR	B&M	Cock.	—	BAG	BRC&W	Alst.
Builder—electrical	—	EEC	SEM	Charl.	EEC	Brush	C-P	Alst.
Owner	Brazil	BR	Belg. Congo	Belg. Congo	NZ	Ceylon	CAR	NS
Service	F&P	P	F&P	F&P	F&P	F&P	F&P	F,P&S
Wheel arrangement	C-C	1-C-C-1	C-C	C-C	2-C + C-2	A1A-A1A	A1A-A1A	B-B
Engine data:								
Engines per cab	2	1	1	1	1	1	1	1
Hp rating per engine	950	1880	1600	1600	1500	1000	850	935
No. of cylinders	—	16	12	8	12	12	6	12
Bore and stroke, in.	—	10×12	$9 \times 10\frac{1}{2}$	$12\frac{3}{4} \times 15\frac{1}{2}$	10×12	$9\frac{3}{4} \times 10\frac{1}{2}$	11×14.2	6.9×7.5
Engine speed, rpm	—	850	1000	625	850	850	700	1500
Cycles	4	4	4	4	4	4	4	4
Supercharging	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Manufacturer	MAN	EEC	ALCO	Cock.	EEC	MBD	Sulzer	MGO
Weight on drivers, lb	171600	246000	204000	213000	155000	129500	90000	132000
Total locomotive weight, lb	171600	297000	204000	213000	234800	195000	134500	132000
Fuel capacity, gal	—	1400	—	650	720	930	840	790
Driving-wheel diameter, in.	—	43	36	36	37	43	36	$39\frac{3}{8}$
Type of transmission	HM	Elec.	Elec.	Elec.	Elec.	Elec.	Elec.	Elec.
Track gage, in.	$39\frac{3}{8}$	$56\frac{1}{2}$	42	42	42	66	42	$56\frac{1}{2}$
Maximum permissible speed, mph	—	—	50	50	60	55	53	50
Fig. No.	5	6	7	8	9	10	11	12

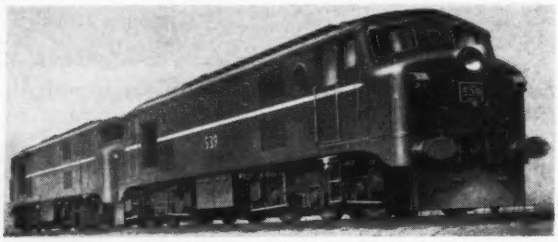


Fig. 10 1000-hp A1A-A1A design of diesel-electric for operation by the Ceylon Railways

Fig. 11 Narrow-gage C-C 850-hp diesel-electric for service by the Australian Commonwealth

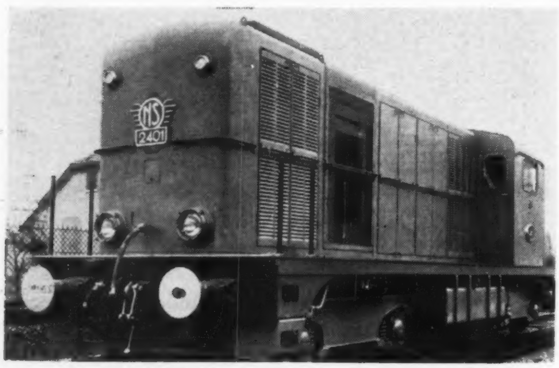


Fig. 12 66-ton B-B general-purpose diesel-electric locomotive built in France with 800-hp high-speed engine

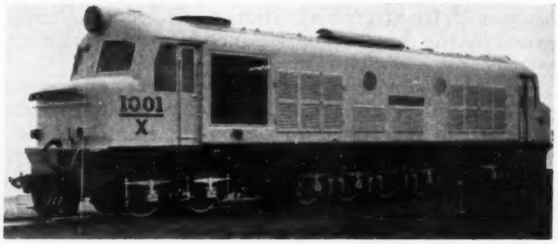


Fig. 13 B-D-B 1105-hp diesel-electric for operation in narrow-gage service of Australia

some 1,292,449 miles in 119 months of service (an average of 10,850 miles per month for the period), ran up 31,357 miles in passenger-train service. Trains hauled by the locomotive run nonstop between Paris and Bordeaux, 391 miles, and average for short sections of the run as high as 87 mph. It should be noted that the monthly mileage of 31,357 has been exceeded by some passenger diesel-electrics operating long runs in the United States.

Lightweight High-Speed Trains and Cars

Spurred on by the burdensome annually recurring deficits accumulated through passenger-train service and the loss of passenger patronage to competing agencies, several railroads are displaying a resurgence of interest in the lightweight, low-center-of-gravity, high-speed train characterized by the "Talgo" type (4) as built by ACF, and as represented by the "Train X" (5) design sponsored by the C&O Ry. The Rock Island placed an order for a four-car 12-unit train of modified Talgo design, and several Eastern railroads, working with car and equipment builders, are actively investigating designs and economics of high-speed lightweight trains for passenger service on American roads.

With a view to eliminating the last of its steam motive power particularly in branch-line and suburban services, the Boston and Maine purchased 55 of the Budd-built RDC cars (6) with the expectation of reducing the railroad's annual passenger deficit by well over a million dollars. The railroad intends to operate the self-propelled cars in trains up to 6 units in multiple-unit in

of Foreign Manufacture

Item No.	9	10	11	12	13	14	15
Builder—mechanical	BP&Co.	Vulcan	NH	Krupp	NBL	VAL	DD
Builder—electrical	M-V	EEC	EMD	—	—	—	Alst.
Owner	West. Aust.	NE	DEN	ISCOR	EB	FSR	ALG
Service	F&P	F&P	P	S	F&P	S	F&P
Wheel arrangement	2-D-2	A1A-A1A	A1A-A1A	D	D	B-B	C-C
Engine data:							
Engines per cab	1	1	1	1	1	1	1
Hp rating per engine	1105	1000	1500	550	530	420	960
No. of cylinders	8	8	16	12	12	6	6
Bore and stroke, in.	$10\frac{1}{2} \times 13\frac{1}{2}$	10×12	$8\frac{1}{2} \times 10$	6.9×8.27	$7 \times 7\frac{3}{4}$	7.3×7.87	9.85×12.6
Engine speed, rpm	625	850	800	1400	1150	1500	1000
Cycles	2	4	2	4	4	4	4
Supercharging	—	Yes	—	Yes	Yes	No	Yes
Manufacturer	Cross.	EEC	EMD	MAN	Paxman	Maybach	Sulzer
Weight on drivers, lb.	87000	107000	161500	132000	96300	107500	156500
Total locomotive weight, lb.	173500	158500	211000	132000	96300	107500	156500
Fuel capacity, gal	1260	600	900	550	378	—	—
Driving-wheel diameter, in.	$31\frac{1}{2}$	37	—	$43\frac{1}{2}$	42	$39\frac{3}{8}$	36
Type of transmission	Elec.	Elec.	Elec.	HM	Hydr.	Hydr.	Elec.
Track gage, in.	42	$39\frac{3}{8}$	$56\frac{1}{2}$	42	42	60	$56\frac{1}{2}$
Maximum permissible speed, mph	55	60	—	18	35	42.5	53
Fig. No.	13	14	15	16	17	18	19

MFE—Maschinenfabrik Esslingen—Germany.
F = Freight, P = Passenger, S = Switching.
BP&Co.—Beyer, Peacock & Co.—England.
BR—British Railways.
M-V—Metropolitan-Vickers Co., Ltd.—England.
EE Co.—English Electric Co.—England.
HM = Hydro-Mechanical, Hydr. = Hydraulic
Cock.—S. A. John Cockerill—Belgium.
Belg. Congo—Belgian Congo Matadi-Leopoldville Ry.
NBL—North British Locomotive Co.—Glasgow, Scotland.
EB—Emu Bay Ry.—Tasmania.
CAR—Central Australia Rys.
C-P—Crompton, Parkinson, Ltd.—England.
Sulzer—Sulzer Bros.—Switzerland
B&M—Baume & Marpent S.A.—Belgium.
SEM—Societe Electro-Mecanique—Belgium.
ALCO—American Locomotive Co.—U. S. A.
IRFA—Industrias E Fabricas de Ferro E Aco—Brazil.
NE—Nordeste Ry.—Brazil.
VAL—Valmet—Finland.
FSR—Finnish State Railways—Finland.
Cross.—Crossley Brothers—England.
Sup.—Superior (U. S. A.).
Alst.—Alsthom—France.
ISCOR—Iron & Steel Corp.—South Africa.
NS—Netherlands State Rys.
MGO—Societe Alsacienne de Constructions Mecaniques—France.
Charl.—Aletiers de Constructions Electriques de Charleroi—Belgium.
BRC&W—Birmingham Railway Carriage & Wagon Works—England.
MBD—Mirrlees, Bickerton & Day—England.
NH—Nydquist & Holm—Sweden.
DEN—Danish State Rys.
ALG—Algerian Railways.
DD—Die Dietrich & Cie—France.
NZ—New Zealand Rys.
Brush—Brush Electric Co.—England.

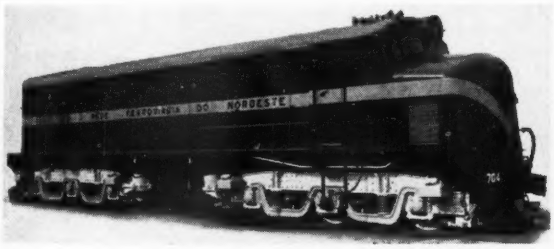


Fig. 14 A1A-A1A British-built 1000-hp diesel electric for Nordeste Railway of Brazil

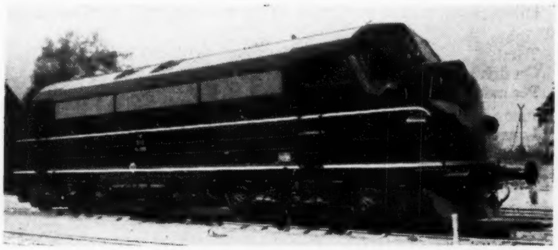


Fig. 15 Danish State Railways 1500-hp diesel-electric built in Sweden with Electro-Motive engine-generator unit

short-stop suburban service—a new application for this type of car.

Diesel Locomotives of U. S. A. Manufacture

With no significant changes in external appearance, the Electro-Motive line of freight and general-purpose road locomotives was up-rated from 1500 to 1750 hp per unit, while the 800-hp switcher was increased in rating to 900 hp. The double-engined A1A-A1A passenger unit rating was increased to 2400 hp from 2000. The increase in engine rating was secured with no change in the cylinder geometry (bore and stroke remain the same as before) but larger injectors and an increase in speed from 800 to 835 rpm are given as the principal reasons for up-ratings by the manufacturer. Salient data are given in items 2 to 6, inclusive, in Table 2.

The 2250-hp C-C general-purpose Alco unit is shown in Fig. 1 and described under item 1 of Table 2.

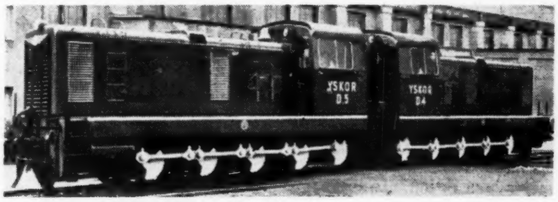


Fig. 16 German-built heavy diesel-mechanical industrial switcher with jackshaft and side-rod drive

A six-motored 1400-hp unit built by General Electric for export and use in several South American countries, is shown in Fig. 2 and described under item 7 of Table 2.

A 1600-hp general-purpose unit was added to its standard line by Fairbanks-Morse. It is described under item 9 of Table 2 and illustrated in Fig. 3.

Fig. 4 and item 8 of Table 2 describe an 800-hp unit

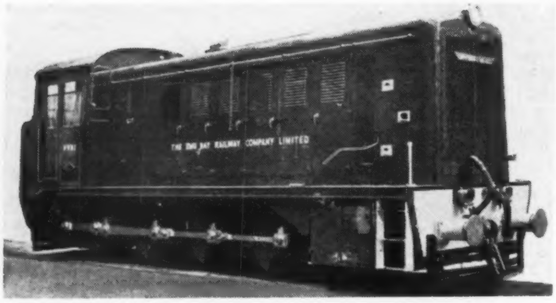


Fig. 17 British-built diesel-mechanical locomotive for main-line service in Tasmania

built by General Electric for service on the 36-in-gage White Pass and Yukon under conditions involving ambient temperatures as low as —60 F. A Vapor-Clarkson hot-water heater is installed to prevent freezing of the engine-cooling water when the engine is not running. Electric heaters of the Calrod type are installed in water tanks to maintain temperatures above freezing under low load or idling conditions. Hot water from the engine-cooling system is circulated to the battery box and through a fuel-oil heat exchanger to maintain proper operating temperatures in these components. Heated cooling air discharged from the engine water-cooling radiators is discharged into the equipment compartment with a view to maintaining cab-interior temperatures above ambient outdoor temperature. A special form of snowplow pilot is provided for bucking snow.

Foreign Diesel Locomotives

Fig. 5 shows a 1900-hp meter-gage locomotive built in Germany with hydromechanical drive, in a total weight of but 86 tons. Available particulars are given under item 1 of Table 3.

An experimental passenger unit rating 1880 hp and with a 1-C-C-1 wheel arrangement is shown in Fig. 6 and described under item 2 of Table 3. The unit is similar to one constructed in 1951 for experimental purposes on the British Railways, except for increased horsepower rating.

Table 4 Electric Locomotives

Item No.	1	2	3	4	5	6	7	8
Builder—mechanical	Alsthom	SLM	Creusot	—	BR	Naval	Alsthom	SLM
Builder—electrical	Alsthom	BBC	Oer. & Jeum.	EEC	M-V	W	Alsthom	Oerlikon
Owner	SNCF	SNCF	SNCF	Victorian	BR	Renfe	SNCF	SNCF
Service	F&P	F&P	F&P	F	P	F & P	F	F
Wheel arrangement	C-C	B-B	B-B	C-C	C-C	B-B-B	C-C	C-C
Power supply	1500V d-c	1500V d-c	1500V d-c	1500V d-c	1500V d-c	3000V d-c	25KV-50cps-a-c	25KV-50cps-a-c
Current collector	Panto	Panto	Panto	Panto	Panto	Panto	Panto	Panto
Driving wheels:								
Number	12	8	8	12	12	12	—	12
Diameter, in.	49.25	51.25	49.25	40	—	44	43¼	43¼
Weights, lb:								
Total	235500	169300	176000	216000	228500	270000	275000	275000
On drivers	235500	169300	176000	216000	228500	270000	275000	275000
Per axle	39250	42300	44000	36000	38100	45000	45500	45500
Dimensions, ft-in.:								
Length over-all	62-10	50-6	53-2	60-10	59-0	66-3	62-0	62-0
Width over-all	9-9	9-8½	9-10	9-3	8-10	10-2	9-6	9-6
Height, panto down	12-1	12-4¼	12-0	13-9	—	14-1	14-0½	14-0½
Rigid wheelbase	15-10½	11-10	10-6	14-4	15-8	9-4	15-4	15-4
Total wheelbase	47-2	36-9	40-8	46-4	46-2	38-2	46-4½	46-4½
Traction motors:								
Number	6	4	4	6	6	6	6	6
Method of mounting	Truck	Truck	Truck	Axle-hung	Axle-hung	Axle-hung	Truck	Truck
Method of drive	Quill	Quill	Quill	Gear	Gear	Gear	Gear	Gear
Gear ratio	2.606	2.02	2.517	—	3.76	3.15	7.79	—
Tractive force, lb:								
One-hour rating	37700	31200	35200	28700	21100	—	—	61600
Per cent adhesion	16.0	18.4	20.0	13.3	9.22	—	—	22.4
Continuous rating	34600	27600	30900	25200	18700	37000	50600	53000
Per cent adhesion	14.7	16.3	17.55	11.65	8.18	13.7	18.5	19.3
Horsepower:								
One-hour rating	4900	4440	4635	2260	2490	—	—	3965
Continuous rating	4590	4070	4170	2045	2298	2950	2460	3440
Speed, mph:								
One-hour rating	48.8	53.4	49.4	29.5	44.3	—	—	24.1
Continuous rating	49.7	55.3	50.6	30.4	46.0	29.5	18.25	24.3
Maximum speed, mph	93.8	87.5	87.5	75	90	81	37½	37½
Electric braking	No	No	No	Rheo.	Regen.	Dyn.	Regen.	—
M-U operation	No	No	No	No	No	—	No	No
Track gage, in.	56½	56½	56½	63	56½	66	56½	56½
Fig. No.	20	21	22	23	24	25	26	—

Alsthom—Alsthom—France.
SLM—Swiss Locomotive & Machine Works—Switzerland.
Creusot—Schneider-Creusot & Cie—France.
BR—British Railways.
Naval—Sociedad Constructors Y Reparaciones Naval—Spain.
BBC—Brown, Boveri & Co.—Switzerland.
Oer.—Oerlikon—Switzerland.
Jeum.—Jeumont—France.
EEC—English Electric Co.—England.
M-V—Metropolitan-Vickers Co., England.
W—Westinghouse Electric Corporation—U. S. A.
SNCF—French National Railways.
Victorian—Victorian Rys.—Australia.
Renfe—Spanish National Railways.
F = Freight.
P = Passenger.
Panto = Pantograph.

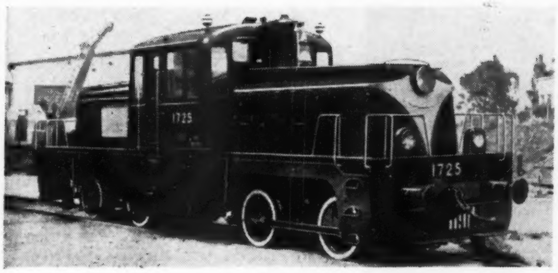


Fig. 18 Center-cab light road-switching diesel-mechanical locomotive built in Finland

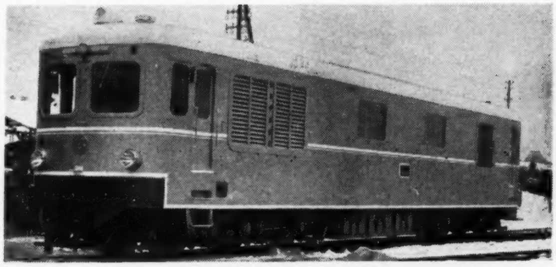


Fig. 19 Double-ended French-built 960-hp diesel-electric for mixed service on Algerian Railways

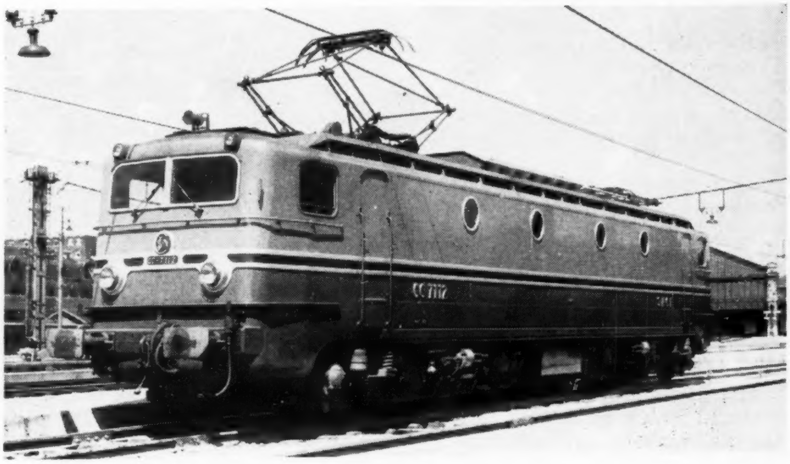


Fig. 20 Alsthom 4590-hp electric passenger unit on French National Railways

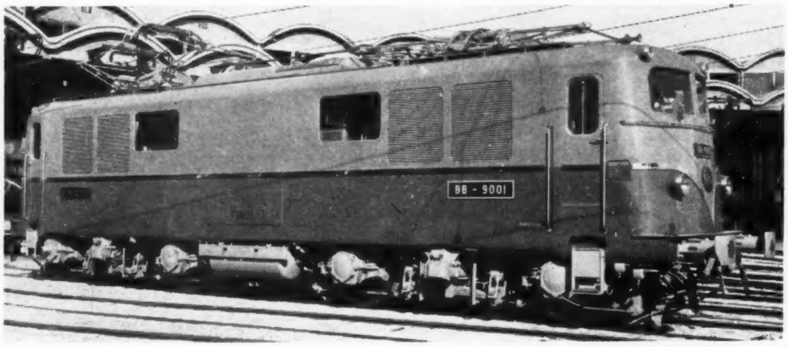


Fig. 21 Swiss Locomotive and Machine Works 4070-hp, 1500-volt d-c electric for SNCF

American design and equipment practices made their appearances in several instances where locomotives were built in European manufacturing establishments under licenses of American manufacturers.

Fig. 7 and item 3 of Table 3 are descriptive of a group of C-C 1600-hp units built in Belgium for service in the Congo, employing American Locomotive Co. engines built in the U. S. A. Belgian-built electrical equipment to General Electric (U. S. A.) designs is employed.

The Belgian firm of John Cockerill, under license of Baldwin-Westinghouse, built a group of 1600-hp C-C units for service in the Belgian Congo, as shown in Fig. 8 and described under item 4 of Table 3. The engine employed is the Baldwin 1600-hp unit commonly used in Baldwin locomotives built for domestic U. S. A. service.

Nydquist & Holm (Sweden), licensees of Electro-Motive, produced a group of four 1500-hp A1A-A1A units (Fig. 15, item 11, Table 3) for the Danish State Railways. Engine-generator equipment for these units was supplied by EMD's LaGrange (U. S. A.) plant. The A1A-A1A wheel arrangement adapts the 110-ton unit to the maximum axle loading of 40,000 lb holding for the Danish lines.

A 1500-hp unit designed for the narrow-gage New

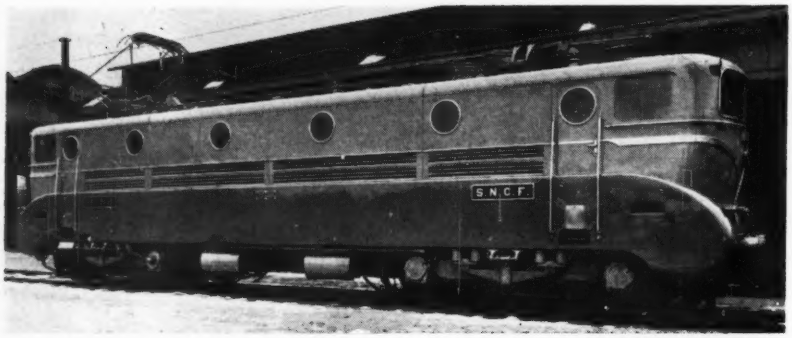


Fig. 22 Creusot-built B-B 4170-hp, 1500-volt d-c electric locomotive for SNCF

Zealand lines (Fig. 9, item 5 of Table 3) is equipped with a 2-C-C-2 running gear to hold the maximum axle-loading within permissible limits.

The A1A-A1A unit shown in Fig. 10 (item 6, Table 3) was built for operation on the broad-gage light-rail Ceylon Railways, with idling axles to provide low individual axle loading.

A narrow-gage (42 in.) unit with a relatively slow-speed engine is shown in Fig. 11 and described under item 7 of Table 3.

Fig. 12 illustrates a high-powered 66-ton general-purpose locomotive built in France for service in Holland. The relatively high horsepower/weight ratio is secured by the use of a 1500-rpm supercharged 12-cylinder engine.

An unusual wheel arrangement, 2-D-2, is employed in the narrow-gage locomotive shown in Fig. 13 and described under item 9 of Table 3.

Another A1A-A1A design with light axle loading is shown in Fig. 14 and described under item 10 of Table 3.

A German-built industrial switcher with a rigid 4-axle wheelbase, side-rod drive, and hydromechanical transmission, arranged for multiple-unit operation is shown in Fig. 16. A similar unit of British construction, but designed for main-line service in Tasmania, is shown in Fig. 17. Both units are designed for 42-in-gage operation.

A center-cab design of locomotive with hydraulic drive and for service in Finland is shown in Fig. 18.

Fig. 19 and item 15 of Table 3 illustate a double-ended diesel-electric for mixed freight and passenger service on the Algerian Railways.

Electric Locomotives

Figs. 20, 21, and 22 and items 1, 2, and 3 of Table 4 describe three high-powered 1500-volt d-c locomotives built by three different manufacturing groups for the French National Railway system. Of particular interest in these designs are the relatively high horsepower per ton characteristics of the two B-B units—in each case the continuous rating approximates 47 to 48, while the 1 hr ratings are 52.5 for both four-axle designs.

Fig. 23 is illustrative of a group of 25 units built for the 1500-volt d-c electric system of the 63-in-gage Victorian Railways operating in Australia. The locomotives are equipped for rheostatic braking rather than regenerative braking, and the accelerating resistors perform a dual role in that they are also employed for the dissipation of braking energy. In anticipation of gage standardization, the truck frames have been built suitable for conversion to the

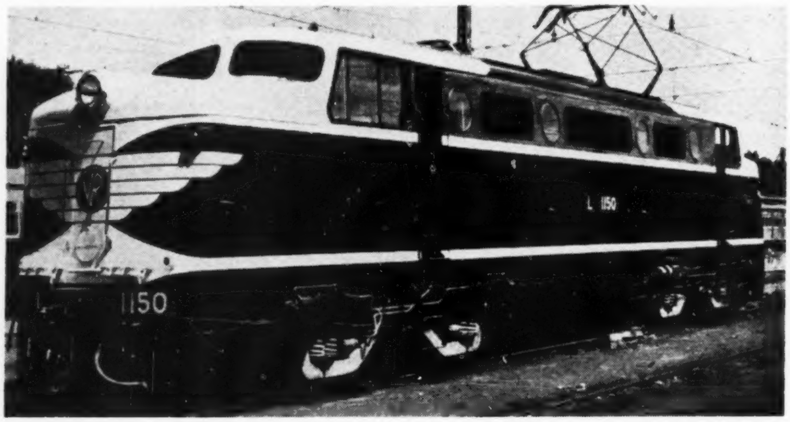


Fig. 23 One of twenty-five 1500-volt d-c electric locomotives for Australian service

Fig. 24 British Railways 1500-volt high-speed passenger locomotive

standard $56^1/_2$-in. gage. Item 4 of Table 4 lists salient dimensional and rating characteristics of these locomotives.

Fig. 24 shows another British-built 1500-volt design for high-speed passenger service on the British Railways.

The 3000-volt B-B-B unit shown in Fig. 25 and described under item 6 of Table 4, was built in Spain to American (Baldwin and Westinghouse) designs. The running-gear arrangement consists of three two-axle trucks, nonarticulated, and without span-bolster equalization. Weight distribution is secured by preloaded springing in the center truck which is arranged to move

laterally in curvature as well as to turn about its center-pin bearing.

Fig. 26 and item 7 of Table 4 describe an electric locomotive of the motor-generator type, built by Alsthom for operation on the newly electrified (at commercial frequency of 50 cps) French National Railways lines in Northeastern France. The locomotive carries a 3000-hp 3-unit motor-generator set operating at 1500 rpm, and each of the two d-c generators (both are driven by a single synchronous a-c motor) feeds three parallel-connected compound-wound (series and separately excited) traction motors. Double-reduction gearing with a ratio of 1 to 7.79 is employed. The locomotives are intended for relatively slow-speed (maximum design speed is but $37^1/_2$ mph) heavy-drag coal-freight service.

A design of locomotive similar in appearance to that of Fig. 26 is described under item 8 of Table 4. Equipmentwise, this locomotive is quite different from that of Fig. 26. The unit described under item 8 is a phase-frequency converter locomotive, utilizing squirrel-cage induction motors as traction motors supplied from a system, the circuit elements of which are shown in Fig. 27. To secure a continuously variable-frequency range for locomotive speed control, two separate rotating motor-generator sets are employed. A synchronous single-phase motor drives a field-controlled d-c generator in one set, and from the stator of the synchronous motor, three-phase energy at 50 cycles is taken to the rotor of the alternator in the second set, which is driven by a d-c speed-controlled motor fed from the d-c generator of the first set. The simple induction traction motors take three-phase energy from the stator of the alternator of the second set, and the frequency is varied by controlling the speed of the driving motor of this frequency changer by varying the d-c voltage of the generator of the first set.

Both locomotives are designed for the same service on the commercial-frequency electrification mentioned previously.

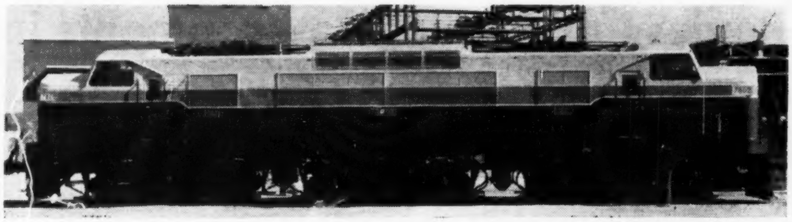


Fig. 25 2950-hp Spanish-built 3000-volt electric of Baldwin-Westinghouse designs

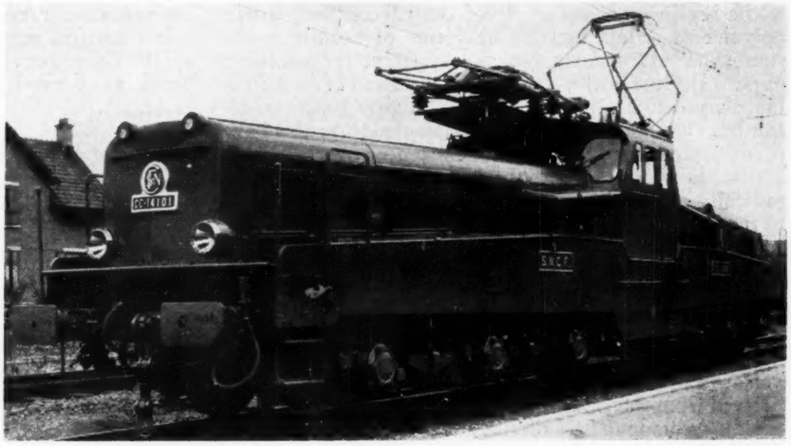


Fig. 26 Commercial-frequency motor-generator locomotive for 25,000-volt single-phase operation in France

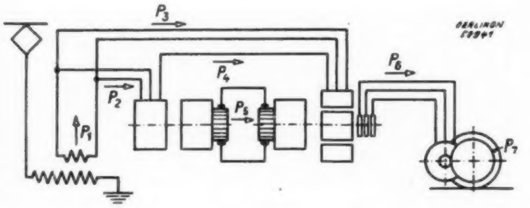


Fig. 27 Simplified schematic connections for commercial frequency-phase frequency-changer locomotive with induction traction motors

Bibliography

1 "Progress in Railway Mechanical Engineering," Mechanical Engineering, March, 1954, pp. 236-238.

2 "An Atomic Locomotive—A Feasibility Study," by G. K. Abel, L. B. Borst, D. M. Bowie, K. W. Petty, B. J. Stover, and M. A. Van Dilla, Department of Physics, University of Utah, Salt Lake City, Utah, January, 1954.

3 "Bulletin of the International Railway Congress," May, 1954.

4 "Progress in Railway Mechanical Engineering," Mechanical Engineering, April, 1950, p. 308.

5 "Progress in Railway Mechanical Engineering," Mechanical Engineering, April, 1950, pp. 312, 315.

6 "Progress in Railway Mechanical Engineering," Mechanical Engineering, April, 1950, p. 311.

7 "Progress in Railway Mechanical Engineering," Mechanical Engineering, April, 1953, p. 301.

8 "Coal-Fired Steam Turbine-Electric Locomotive for Norfolk and Western Railway Company," by R. P. Stoddart, C. C. Hamilton, and P. D. Evans, presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of The American Society of Mechanical Engineers. Paper No. 54—A-185.

9 "Performance of Norfolk and Western Railway Company's Experimental Coal-Burning Steam Turbine-Electric Locomotive No. 2300," by I. N. Moseley, presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of The American Society of Mechanical Engineers. Paper No. 54—A-251.

(To be concluded in May, 1955)

Review of Plastics Developments in 1953-1954

By F. J. McGarry

Department of Civil and Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Associate Member ASME

PERHAPS the most provocative single development which has occurred in the plastics field in the past year is the recognition and study of the effects produced in polymer materials by various forms of atomic radiation (1).[1] As an example, the apparent cross-linking of polyethylene with a consequent elevation of its softening temperature (2,3) constitutes a highly beneficial effect but numerous cases of material degradation also have been observed (4,5,6). The existence of the latter action does not negate the possibility, however, of radically altered plastics being procured by this process in the near future.

New Synthetic Materials

On the more conventional plane of synthesis, advances in the development of new materials, or new forms of older polymers, continue steadily. One of the most versatile of these is the family of polyurethane resins, derived from the isocyanates, and useful as fibers, foams, molding compounds, adhesives, elastomers, and coatings (7,8). European experience with these forms is more extensive than our own but at present considerable activity in this country is under way.

Of equal importance and similar promise is the epoxy family, especially when used in conjunction with other plastics (9,10) for mutual modification of properties and characteristics. Another polymer, elastomeric in nature, is a chlorosulphonated polyethylene whose unusual properties are being reported (11) and which appears to be well suited to a number of applications.

Interest in the fluorocarbons continues high (12,13) and advances in fabrication techniques (14,15) widen the field of applications in which their unique properties can be employed (16,17).

Another group of resins, the allyls, while not newly created, appears to be growing in importance, especially in the low-pressure thermosetting laminate field where their addition polymerization results in the formation of no reaction by-products (18). While presently expensive, their wider use no doubt will result in price reductions.

Other new materials include foamed silicones (19) for thermal insulation, a very low dielectric-loss form of cellular polyethylene (20), and foams of phenolic (21), polystyrene (22), and vinyl (23), the latter in competition with sponge and foam rubber. Improved glazing materials have been reported (24) to meet the increasingly severe requirements of high-speed aircraft use.

The omnipresent polystyrene has recently appeared in several new forms. An unfilled but greatly toughened type of the polymer has been introduced (25) while molding compounds reinforced with glass fibers offer unusual characteristics (26,27) though certain fabrication problems are encountered.

Information regarding polyester-film properties and applications continues to be reported (28,29) while the problems of vinyl compounding also receive study (30, 31,32,33).

Properties of Plastics

Several valuable and extensive discussions of the mechanical properties of plastics have become available (34,35,36) while a much-needed investigation into the properties of thin-film materials was recently reported (37). As the interest in architectural applications of plastics grows, information regarding the behavior of plastics in exposed locations becomes current (38,39,40). The subject of crazing, caused by a variety of factors, continues to receive much attention (41,42,43) while certain means of suppressing this deterioration have been studied (44). A simple method of observing the threshold stress for crazing of polystyrene is reported (45) while another new approach has been applied to the testing of thin films (46). The frictional behaviors of several plastics including polyethylene, fluorocarbons, and vinyls were fundamentally investigated (47). A discussion of other mechanical properties of polyethylene is also available (48). The study of effects of residual stresses in phenolics and vinyls has provided new information (49,50).

Fabrication Methods

By far the most important advances which have recently taken place in this aspect of plastics technology are associated with injection molding and extrusion. Fundamental analyses of the former have done much to establish more rational methods of operation (51,52,53) while development investigations continue to reveal useful techniques (54 to 62). As would be expected with injection equipment, the emphasis is on speed and automation (63,64) but attention also is devoted to enhancing the range of plastics which can be molded (65). Extrusion is studied (66,67) and recent interesting work on calendering has been reported (68). Slush molding (69), slurry preforming (70), embedding (71), wood-waste board fabrication (72), acrylic forming (73), paper coating (74) and vacuum forming (75) all continue to provoke interest and enthusiasm.

Engineering Applications

Engineering applications of unreinforced materials continue to increase. Often such are predicated upon chemical inertness (76), lightness and portability (77), or unique physical properties (78). Low coefficients of friction and initial-investment economics continue to render plastic tooling attractive in the metals-forming

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Rubber and Plastics Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

field (79,80). The mechanical damping capacity of certain polymers has resulted in their use for low-load gearing where the noise level is of importance (81). A comprehensive survey of industrially used plastics is available (82).

Composite Materials

The fiberglas-reinforced plastics only recently have been accorded a reasonably comprehensive treatment (83) which fills a heretofore critical void in easily available information. The book (83) by Sonneborn covers many phases of the subject and represents a valuable source of information for workers in the field.

A new form of woven fiberglas roving provides a reinforcing structure submissive to good resin penetration and easy handling at a cost not much greater than that of mat (84). Work continues on finishes to improve the bond between glass and plastic (85) and the range of materials available has been described (86,87,88,89). Interesting types of sizing for the fiberglas also are reported (90) while the general problem of adhering to glass has been reviewed (91). Much interest has been generated by the improvement in phenolic moldings from the use of glass-fiber reinforcement (92). Improved methods of fabrication also extend the uses of glass-filled materials (93,94) which already embrace such applications as aircraft (95), jigs and tooling (96,97,98), boats (99), automobiles (100), transportation (101,102,103), guided missiles (104), armor (105), and structures (106, 107).

Honeycomb and sandwich structures continue to find important uses as fabrication improvements enhance their properties (108,109,110). High-pressure laminates also undergo study in terms of both mechanical (111) and electrical properties (112,113) with much emphasis upon elevated-temperature performance (114).

Coatings and Adhesives

In the field of protective coatings, two lines of development predominate. Chemical and physical research is executed to upgrade the quality and permanence of the more easily applied coatings (115,116, 117) and to understand the effect on performance of certain controlled variables (118). At the same time, new techniques are being worked out to apply such plastics as polyethylene, nylon, epoxies, and others, inherently more durable, to commonly encountered surfaces (119, 120,121) in an economical fashion.

As our understanding of the actions of synthetic adhesives becomes empirically wider, more confident use of them may be made in engineering tasks (122,123,124, 125,126). At the same time more refined methods of testing adhesive joints to provide further information are being devised (127).

Bibliography

Materials

1 "Effects of Atomic Radiation on High Polymers," by H. K. Sun, *Modern Plastics*, vol. 32, September, 1954, p. 141.

2 "Evaluation of Polyethylene Crosslinked by Ionizing Radiation," by G. J. Dienes, et al., *Journal of Polymer Science*, vol. 13, April, 1954, p. 140.

3 "Irradiated Polyethylene," *Modern Plastics*, vol. 31, April, 1954, p. 100.

4 "Effects of Atomic Radiation on Polymers," by L. A. Wall and M. Magat, *Modern Plastics*, vol. 30, July, 1953, p. 111.

5 "Radiation of Polytetrafluoroethylene," by J. W. Ryan, *Modern Plastics*, vol. 31, October, 1953, p. 152.

6 "Effects of Pile Radiation on Electrical Insulation," by J. W. Ryan, *Modern Plastics*, vol. 31, April, 1954, p. 140.

7 "Polyurethane Resins," by J. Bjorksten, H. Tovey, H. L. Dollard, Jr., *Modern Plastics*, vol. 31, April, 1954, p. 143.

8 "Chemigum SL—An Elastomeric Polyester—Urethane," by N. V. Seeger, et al., *Industrial and Engineering Chemistry*, vol. 45, November, 1953, p. 2538.

9 "Recent Developments in Ethoxyline Resins," by J. B. D. MacKenzie, *Adhesives and Resins*, vol. 1, September, 1953, p. 179.

10 "Recent Developments with Epoxy Resins," by J. E. Carey, *Modern Plastics*, vol. 30, August, 1953, p. 130.

11 "Chlorosulfonated Polyethylene. A New Elastomer," by R. E. Brooks, D. E. Strain, and A. McAleney, *India Rubber World*, vol. 127, March, 1953, p. 791 (see also April and June, 1953, issues).

12 "Polytetrafluoroethylene–Its Properties and Uses," by L. W. Cornell, MECHANICAL ENGINEERING, vol. 75, November, 1953, p. 883.

13 "How to Tell Quality in Teflon," by I. D. Press, *Materials and Methods*, vol. 38, October, 1953, p. 64.

14 "Pelleting of PTFE," *British Plastics*, vol. 27, August, 1954, p. 312.

15 "Teflon Joined by Fusion Bonding," by H. G. Henry, *Materials and Methods*, vol. 38, October, 1953, p. 114.

16 "Superpipe," *Modern Plastics*, vol. 31, April, 1954, p. 105.

17 "Frictional Properties of Porous Metal Impregnated With Plastic," by F. P. Bowden, *SPE Journal*, vol. 10, March, 1954, p. 38.

18 "The Allyl Resins," by L. Lynn, *Modern Plastics*, vol. 31, October, 1953, p. 139.

19 "New Silicone Resin—Foamed in Place—Is High Temperature Insulator," *Materials and Methods*, vol. 38, November, 1953, p. 96.

20 "Cellular Polyethylene by Extrusion," by W. T. Higgins, *Modern Plastics*, vol. 31, March, 1954, p. 99.

21 "Phenolic Foam," by J. D. Nelson, *SPE Journal*, vol. 9, December, 1953, p. 14.

22 "Polystyrene Foam," by R. N. Kennedy, *SPE Journal*, vol. 9, December, 1953, p. 11.

23 "Vinyl Foamed With Gas," *Modern Plastics*, vol. 31, April, 1954, p. 136.

24 "New Transparent Plastics," by C. R. Riley, *Modern Plastics*, vol. 31, October, 1953, p. 107.

25 "New Toughened Polystyrene," *British Plastics*, vol. 27, May, 1954, p. 189.

26 "Jobs for a New Material," *Modern Plastics*, vol. 31, April, 1954, p. 109.

27 "Polystyrene Reinforced With Glass Fibers," by H. G. Guy, *SPE Journal*, October, 1953, vol. 9, p. 16.

28 "The Fabulous Film," *Modern Plastics*, vol. 32, September, 1954, p. 110.

29 "High Temperature Resistivity of Polyester Dielectric Film," by L. E. Ambroski and R. L. Burton, *Electrical Manufacturing*, vol. 53, March, 1954, p. 124.

30 "Plasticizers for Vinyls," by J. J. Morris, *Modern Plastics*, vol. 31, October, 1953, p. 116.

31 "Stabilization of Polyvinyl Chloride," by G. P. Mack, *Modern Plastics*, vol. 31, November, 1953, p. 137.

32 "Plasticizers for Vinyls," by H. S. Bergen, E. E. Cowell, and W. Waychoff, *Modern Plastics*, vol. 31, November, 1953, p. 93.

33 "Plasticizers for Vinyls," by E. B. Deckel, *Modern Plastics*, vol. 31, December, 1953, p. 98.

Properties

34 "Measurement and Significance of the Mechanical Strength Properties of Plastics," by C. H. Adams, ASTM Special Technical Publication No. 132, 1953.

35 "Measurement of the Effect of Temperature on Some Physical Properties of Plastics," by E. B. Cooper, A. C. Webber, J. P. Tordella. ASTM Special Technical Publication No. 132, 1953.

36 "Effects of Molding Conditions Upon the Permanence of Plastics," by J. L. Williams and J. W. Mighton, ASTM Special Technical Publication No. 132, 1953.

37 "Properties of Plastic Films," by M. C. Sloan and F. W. Reinhart, *Modern Plastics*, vol. 31, June, 1954, p. 203.

38 "Three Years' Outdoor Weather Aging of Plastics Under Vari-

ous Climatological Conditions," by S. E. Yustin, R. M. Winans, H. J. Stark, ASTM Bulletin No. 196, February, 1954, p. 29.

39 "Effect of Heat and Light on Polyvinyl Chloride," by D. Druesedow and C. D. Gibbs, *Modern Plastics*, vol. 30, June, 1953, p. 123.

40 "Oxidative Aging of Polyethylene," by R. S. Biggs and W. L. Hawkins, *Modern Plastics*, September, 1953, p. 121.

41 "Stress-Solvent Crazing of Acrylics," by B. M. Axilrod and M. A. Sherman, *Modern Plastics*, vol. 30, June, 1953, p. 130.

42 "Stress Crazing of Plastics," by J. A. Sauer and C. C. Hsiao, Trans. ASME, vol. 75, July, 1953, p. 895.

43 "Stress and Strain at Onset of Crazing of Polymethyl Methacrylate at Various Temperatures," by M. A. Sherman and B. M. Axilrod, ASTM Bulletin No. 91, July, 1953, p. 65.

44 "Biaxial Stretch-Forming of Acrylics," by I. Wolock, B. M. Axilrod, M. A. Sherman, *Modern Plastics*, vol. 31, September, 1953, p 128.

45 "Crazing of Polystyrene," by E. E. Zeigler, *SPE Journal*, vol. 10, April, 1954, p. 12.

46 "A Constant Strain Stiffness Tester for Thin Plastic Films," by F. D. Dexter, ASTM Bulletin No. 192, September, 1953, p. 40.

47 "Frictional Properties of Plastics," by R. C. Bowers, W. C. Clinton, and W. A. Zisman, *Modern Plastics*, vol. 31, February, 1954, p. 131.

48 "Mechanical Properties of Polyethylene," by R. H. Carey, *SPE Journal*, vol. 10, March, 1954, p. 16.

49 "Residual Stresses in Phenolic Plastics," by L. E. Welch and H. M. Quackenbos, Jr., ASTM Special Technical Publication No. 132, 1953, p. 47.

50 "Dimensional Changes in Rigid Vinyls," by M. L. Dannis, *Modern Plastics*, vol. 31, March, 1954, p. 120.

Fabrication

51 "Energy Conversions in the Flow of High Polymers: Applications to Injection Molding," by H. L. Ton and S. D. Eagleton, *Journal of Applied Mechanics*, Trans. ASME, vol. 76, 1954, p. 354.

52 "Pressure Effects During the Injection Molding of Polystyrene," by S. D. Eagleton, *British Plastics*, vol. 27, March, 1954, p. 85.

53 "Temperature Control in Injection Molding," by L. Griffiths, *British Plastics*, vol. 27, April, 1954, p. 134.

54 "Mold Temperature Control," by C. A. Whitlock, *Modern Plastics*, vol. 31, October, 1953, p. 131.

55 "Injection Speed," by P. E. Schmidt, *Modern Plastics*, vol. 31, November, 1953, p. 119.

56 "Increasing Molding Efficiency," *Modern Plastics*, vol. 31, March, 1954, p. 105.

57 "Molds and Stresses," by G. Stimpson, *British Plastics*, vol. 26, November, 1953, p. 402.

58 "Injection Molding of Polyamides," by L. Griffiths and M. G. Munns, *British Plastics*, vol. 27, September, 1954, p. 352.

59 "New Concept of Hot-Runner Molding," *Modern Plastics*, vol. 32, September, 1954, p. 123.

60 "What Causes Mold Erosion," by A. P. Landall, *Modern Plastics*, vol. 32, September, 1954, p. 131.

61 "Injection Molding Rigid Plastics," *Modern Plastics*, vol. 31, December, 1953, p. 113.

62 "Some Design Considerations for Injection Molding Heating Chambers," by G. D. Gilmore and G. B. Thayer, Trans. ASME, vol. 75, July, 1953, p. 903.

63 "Universal Injection Machine," *Modern Plastics*, vol. 30, June, 1953, p. 115.

64 "1200 Shots Per Hour," *Modern Plastics*, vol. 30, June, 1953, p. 120.

65 "Restricted Gating," by R. Bostwick and C. A. Joslin, *Modern Plastics*, vol. 31, October, 1953, p. 125.

66 "A Statistical Study of Extrusion Variables," by R. E. Colwell, *SPE Journal*, vol. 9, June, 1953, p. 16.

67 "A New Look at Extrusion," by H. O. Corbett, *Modern Plastics*, vol. 31, June, 1954, p. 198.

68 "Modifying Temperature Distribution Over Calender Rolls by Electro-Magnetic Induction," by G. Ardichvili, *British Plastics*, vol. 26, November, 1953, p. 400.

69 "Slush Molding Molds and Techniques," by E. R. Greenspun, *Modern Plastics*, vol. 30, July, 1953, p. 97.

70 "Why and How of Slurry Preforming," by A. C. Weiss and J. C. Williams, *Modern Plastics*, vol. 31, November, 1953, p. 99.

71 "Embedding in Acrylics," by A. J. Spliner, *Modern Plastics*, vol. 31, November, 1953, p. 129.

72 "Continuous Production of Resin-Bonded Woodboard," *British Plastics*, vol. 26, August, 1953, p. 290.

73 "Free Drawing Acrylic Canopies," *British Plastics*, vol. 27, March, 1954, p. 85.

74 "Polythene Paper-Coating Plant," *British Plastics*, vol. 27, September, 1954, p. 345.

75 "Automatic Sheet Forming," *Modern Plastics*, vol. 30, July, 1953, p. 106.

Applications

76 "Plastics for Chemical Engineering Construction—Unplasticized Polyvinylchloride," by G. S. Laaf, *Chemical Engineering Progress*, vol. 50, June, 1954, p. 275.

77 "Futures for Plastic Pipe," *Modern Plastics*, vol. 31, March, 1954, p. 73.

78 "Silicone Rubber as Electrical Insulation," by A. E. Javitz, *Electrical Manufacturing*, vol. 53, February, 1954, p. 126.

79 "Metal Working Swings to Plastic Tools," *Modern Plastics*, vol. 32, September, 1954, p. 85.

80 "Forming Steel With Plastic Dies," *Modern Plastics*, vol. 31, September, 1953, p. 109.

81 "Engineering Nylon Gears," by J. H. Kuhn, *Modern Plastics*, vol. 31, September, 1953, p. 115.

82 "Industrial Plastics," by W. M. Bruner and P. J. Wayne, *Chemical Engineering*, vol. 60, July, 1953, p. 193.

Composite Materials

83 "Fiberglas Reinforced Plastics," by Ralph Sonneborn and others, Reinhold Publishing Corp., New York, N. Y., 1954, 240 pp.

84 "Woven Glass Roving," *Modern Plastics*, vol. 31, February, 1954, p. 75.

85 "Finishes for Glass Fabrics for Reinforcing Polyester Plastics,' by L. J. Biefeld and T. E. Phillips, *Industrial and Engineering Chemistry*, vol. 45, June, 1953, p. 1281.

86 "Glass Reinforced Polyesters—Resins, Fibers and Properties," by E. M. Evans, A. M. Dobson, L. Welsh, *British Plastics*, vol. 27, March, 1954, p. 100.

87 "Polyester-Glass Molding Compounds," by H. R. Sheppard, *Modern Plastics*, vol. 31, April, 1954, p. 121.

88 "Highly Filled Glass-Polyester Plastics," by R. F. Shannon, L. J. Biefeld, *Modern Plastics*, vol. 31, December, 1953, p. 125.

89 "Glass-Reinforced Plastics—Recent Changes and Developments," by D. D. Hodgson and G. Ader, *Plastics* (London), vol. 18, June, 1953, p. 202.

90 "PVA Emulsion Sizes for Glass Cloth," by P. R. Mosek, *British Plastics*, vol. 27, April, 1954, p. 142.

91 "Glass Bonding," by F. Moser, *Modern Plastics*, vol. 31, February, 1954, p. 107.

92 "Phenolic-Glass Molding Compound," *Modern Plastics*, vol. 31, September, 1953, p. 169.

93 "Extruded Reinforced Plastics," *Modern Plastics*, vol. 31, December, 1953, p. 105.

94 "Reinforced Plastics By-the-Yard," *Modern Plastics*, vol. 31, February, 1954, p. 89.

95 "The Plastics Era in Aircraft," *Modern Plastics*, vol. 30, July, 1953, p. 71.

96 "Reinforced Plastics Tooling," *Modern Plastics*, vol. 30, June, 1953, p. 107.

97 "Aircraft Jigs in Glass-Reinforced Polyester," *British Plastics*, vol. 27, June, 1954, p. 206.

98 "Laminate Jigs and Tools in the Aircraft Industry," *British Plastics*, vol. 26, October, 1953, p. 370.

99 "Recent Developments in Glass-Polyester Boat Production," *British Plastics*, vol. 27, May, 1954, p. 154.

100 "New Tools, New Plants for Car Bodies," *Modern Plastics*, vol. 31, August, 1954, p. 115.

101 "Sandwich Walls for Milk Tank," *Modern Plastics*, vol. 31, February, 1954, p. 87.

102 "Truck Trailers," *Modern Plastics*, vol. 31, October, 1953, p. 99.

103 "Vehicle Bodywork in Laminate," *British Plastics*, vol. 18, October, 1953, p. 376.

(*Continued on page* 332)

Disposing of Radioactive Wastes

By Abel Wolman[1] and Arthur E. Gorman[1]

Atomic Energy Commission, Washington, D. C.

Radioactive-waste disposal from the atomic-energy industry presents many problems of special interest to the mechanical engineer. These problems include: (*a*) Design of facilities to ventilate and to remove from working areas radioactive dusts, fumes, and gases; (*b*) research in disposal of combustible radioactive wastes by incineration and related processes; (*c*) development of sensitive remote-control equipment for handling and transporting highly radioactive materials; and (*d*) improving methods of heat exchange where extraordinary temperature conditions exist. The solution of these difficulties requires teamwork of technical experts of many specialties. The paper discusses these problems in some detail.

There is pressing need for more economical methods of disposal of radioactive wastes because of the widespread and accelerating expansion of the nuclear industry toward centers of population. This situation is being met by the Atomic Energy Commission through research and development activities broader in scope and more intensive in character than the attacks upon waste-disposal problems of any other major American industry in its early development.

To obtain proper perspective as to the potentialities of this problem, one needs but to recall the unfortunate experience in disposal of wastes from other industries and the effects of the wastes on nearby communities.

In less than a decade the capital investment in the new atomic-energy industry has reached nearly five-billion dollars, exceeding that of any other major industry in this country.

In spite of this phenomenal increase in plant and related production, hazards in the disposal of radiation wastes so far have been kept at a minimum. This is not to say that hazards do not exist or that problems have not arisen. However, the problems are being met even though the costs are relatively high. Improvement in methods and facilities for control of radioactive wastes and reduction in cost are among the important challenges of the industry as it moves forward.

[1] Consultant and Sanitary Engineer, respectively.

Contributed by the Safety Division and presented at a joint session of the Safety Division and the Nuclear Energy Application Committee at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of The American Society of Mechanical Engineers. Slightly condensed from ASME Paper No. 54—A-72. For complete details refer to the original paper.

Characteristics of Radioactive Wastes

Levels of Activity. In general, high-level wastes in the atomic-energy industry are those requiring extensive shielding to protect persons handling them from exposure to damaging radiation. Such waste may contain as much as 10^2 curies per liter. Fortunately they are produced in much less volume than those of intermediate and low levels. It is difficult to estimate the percentage of total waste production which is high-level activity, because of the variety in kinds of wastes. They might be as low as 0.5 and as high as 50 per cent depending upon the material being processed at a plant.

Intermediate-level wastes also require shielding and must be handled with much care. The low-level wastes are those which if decontaminated by a factor of 10^2 or 10^3 would approach permissible limits for human exposure. The range of their activity would be from 10^{-4} to 10^{-3} microcuries per milliliter.

Kinds of Wastes. Radioactive wastes may be in liquid, gaseous, solid state, or in some intermediate form. They may be combustible or noncombustible. The kind and intensity of radioactive wastes are not detectable by the human senses. These insidious characteristics make radioactive wastes especially dangerous because they could be released to the air, the soil, or to surface waterways without detection. With proper instrumentation and radiometric analytical techniques, however, the constituents and characteristics of radioactive wastes may be determined with accuracy.

Important from the waste-disposal point of view are the long half lives and known damaging properties to human tissue of certain of the isotopes. Regardless of what is done to, or what use is made of, a radioisotope, it will continue to give off radiation at its natural decay rate. As long as its radioactivity is in excess of permissible limits of exposure a radioisotope is a potential hazard to man.

These unique properties of radioactive wastes place more than average responsibility on those responsible for their disposal and also on officials charged with the protection of public health and natural resources.

Sources and Treatment of Radioactive Wastes

Radioactive waste products have numerous sources and each must be evaluated carefully before wastes are treated and disposed of. Current practices while adequate are costly and necessarily conservative. The development of more effective and economic methods of disposal of these wastes is one of the important areas of research and development by the Atomic Energy Commission. Special emphasis is being given to environmental problems in the disposal of these wastes, because as private industry uses atomic energy its plants must be reasonably near the populations it is to serve. This is in contrast with some of the early large plants operated by the AEC which have been deliberately located remotely from large centers of population and other industries.

Raw Materials. Every industry creates some waste in progressing from raw material to finished product. In the atomic-energy industry the levels of activity of radioactive wastes increase progressively as industrial processes develop.

Ores. Currently the important raw materials are the radioactive ores of uranium. A product of radioactive decay of these ores is radon. This gas when breathed into the lungs in sufficient concentrations can cause serious harm. With good ventilation the level of radon can be held to within the current standard of 8×10^{-12} microcuries per milliliter of air. Dusts of the ores are kept to a minimum level and this is accomplished by methods common to other mining operations.

The progressive processing of the radioactive ores to the ultimate preparation of enriched feed material is complicated and results in considerable volumes of long-lived alpha-emitting wastes. These processes are chemical and metallurgical and involve some machining. Chemical sludges containing uranium and giving off radon usually are held in concrete storage basins. They are low in specific activity and generally represent no serious local hazard. Because of the very long periods they will remain radioactive they will continue to present a problem in storage. The dusts and chips from metallurgical and machining processes are usually recoverable and can be prevented from being a health hazard to operators by good industrial housekeeping and use of adequate ventilation facilities.

Fumes and Dusts. Fumes and dusts are removed as near as possible to the source of production by mechanical ventilating systems. Various air-cleaning facilities are used such as inertial separators, bag, bed and membrane filters, scrubbers, and electrostatic precipitators. Specifications for air-cleaning equipment must be much more rigid than those of most industries.

Coolants From Nuclear Reactors. Another important source of wastes in the atomic-energy industry is associated with the cooling of nuclear reactors. When the fuel is irradiated by neutrons, tremendous amounts of heat are produced. Reactors may be cooled by air, water, or by other media with suitable fluid and heat-exchange properties. Since in passing through the reactor core these media are exposed to neutrons, they become irradiated. The radioisotopes formed depend on the composition of the cooling media. The problem of disposal of the irradiated media varies, depending on its volume, the level of its radioactivity, and the suitability of local conditions for release of the coolant, without creating environmental hazards.

Air. In the case of an air-cooled reactor, such as the one at the Brookhaven National Laboratory, the coolant flow through the reactor is at a rate of 300,000 cfm. To avoid creating an environmental hazard the air in this system is prefiltered to remove dusts which otherwise would become radioactive when passing through the reactor. Under the neutron bombardment of the air coolant, radioactive argon, xenon, and krypton are formed. The irradiated air is discharged to the atmosphere through a stack over 300 ft high. Meteorologists have studied intensively the atmospheric conditions at Brookhaven and the effects of the reactor operations. The dilution is normally such that the radioactivity is well below permissible limits in air breathed by humans.

Single-Pass Water. The Hanford reactors are cooled by a single pass of water from the Columbia River. The river water is purified by chemical coagulation, settling, and filtration in much the same way as water is treated for public water-supply systems. During the first few hours after leaving the reactor the rate of decay of radioactivity in the cooling water is high. Advantage is taken of this phenomenon by holding the water in retention basins for various periods prior to release to the river. The residual activity in the effluent water is diluted in the river after release through multiple outlets to improve dispersal. The river water is carefully monitored for radioactivity.

Recirculated Water. Other types of reactors such as the Materials Testing Reactor (MTR) at the National Reactor Testing Station in Idaho use closed cooling systems. They too are not free of problems in disposal of wastes. In a closed system using water it is customary to filter and to demineralize the coolant so that there will be little or no material in the water to become irradiated. In practice, however, since this water must pass through pipes, pumps, and heat-exchange facilities of one sort or another, it will eventually pick up some contamination. In order to hold down any marked increase in radioactivity in such systems, a small percentage of the total flow is bled off, filtered, passed through demineralizing media and then returned to the main stream. In other cases the bleed-off water is wasted. The waste water or the spent filter media and the demineralizing materials eventually acquire radioactivity and are disposed of usually by land burial.

Other Reactor Waste Problems. When a reactor is disassembled or parts which have become irradiated are removed a problem in disposal of the first order is presented. Extraordinary care is given to shield workers and the time and amount of their exposure is controlled rigidly. It is customary to hold highly active material in a designated fenced-off area or to bury it in a designated burial ground with adequate cover to shield against surface exposure. An inventory of buried radioactive materials is maintained.

Chemical Processing. The high-level wastes originate principally, but not entirely, from the chemical processing of fuel from nuclear reactors in order to recover unburned portions. Associated with the irradiated fuel are many fission products with radioactive half lives varying from seconds to millions of years. Such products have fixed rates of radioactive decay which never vary. Customarily, the irradiated fuels as removed from a reactor are stored under water in order to permit decay of the short-lived fission products. Storage from 90 to 120 days is desirable, but processing within shorter periods may be necessary. With shorter periods of storage problems of handling and disposing of the product are intensified.

Significant Isotopes. Of special significance, because of half life or radiotoxicity in disposal of atomic-energy wastes from chemical processing are the isotopes given in Table 1.

Table 1 Significant Isotopes in Atomic-Energy Wastes

Radioisotope	Mass number	Atomic number	Half life
Strontium	90	38	19.9 years
Strontium	89	38	53 days
Iodine	131	53	8.1 days
Niobium	95	41	35 days
Cerium-Praseodymium	144	58–59	280 days
Xittrium	91	39	61 days
Barium	140	56	12.8 days
Zirconium	95	40	65 days

Recent Methods. In recent years improvements have been made in the chemical-dissolving, extraction, and stripping processes and facilities. Most important is the effort to remove these highly active wastes at the point of origin—where the volume is small—rather than to permit them to mix with and contaminate a high-volume system where decontamination is very expensive. Formerly, nitrogen-oxide fumes and iodine vapors arising from fuel-dissolving operations were released to the atmosphere through high stacks. Now these fractions of gaseous effluents are removed by scrubbers and by the use of a chemical reaction involving silver nitrate. Highly radioactive particulates varying in size from 50 microns to fractions of a micron are now being removed in deep-bed sand and glass-fiber filters of high efficiency, Glass-fiber filters (99.95 per cent removal efficiency for 0.3-micron particles) are manufactured commercially based on research and development work financed by AEC. Presently these filters will handle gaseous effluents up to 600 F. Similar media to perform satisfactorily at 1500 F are being developed.

Prior to discharge of liquid wastes to tanks and in an effort to concentrate radioactivity in as small a volume as practical, coprecipitation processes in series are sometimes used. The supernatants of low activity are released to the ground usually through cribs and reverse wells. Concentrates are stored in underground tanks. Evaporation also has been used extensively to reduce volume of liquid wastes, both of high and intermediate levels of activity. High-level radioactive wastes also can be reduced in volume by ion-exchange methods.

Storage Underground. Storage of highly radioactive wastes in large underground steel and steel-and-concrete tanks as currently practiced presents a real problem. Primarily, it is costly, the capital cost varying from \$0.35 to \$1.75 per gal of capacity. The thermal heat which results from gamma radiation is very high. In order to protect the tanks from deterioration by corrosion, excess heat must be carried away by a cooling system. In order to detect leaking from these tanks a system of drains is installed around them leading to a monitoring pit. The true life of these tanks is an unknown factor. It is certainly much shorter than the length of time some of the long-lived radioactive materials will continue to be hazardous. It is not a simple task to remove entirely the high-level radioactive material after it has been stored in a tank over an extended period. Steam jetting is one method in use.

Environmental Considerations. Environmental factors, such as the capacity of soils in the vicinity of these tanks to absorb radioactive wastes, should they leak, and the rate of movement of such wastes through the soils, especially to underground sources of water supply, are extremely important. They are being studied under AEC sponsorship in co-operation with the Geological Survey.

Ultimate Disposal. At the Brookhaven National Laboratory, Hatch and his associates sought a means of ultimate disposal of radioactive wastes. They have developed a method of absorbing high-level fission products in specially prepared and extruded montmorillonite clay pellets. These pellets are then subjected to high temperature (800 to 1000 C) in a kiln to form hard ceramic beads from which the radioactive material cannot be leached. This process is in the pilot-plant stage and has hope of economic feasibility.

Ocean Disposal. Proposals have been made that high-level radioactive wastes be disposed of by dumping to the oceans in deeps far off shore, as is now practiced for disposal of miscellaneous industrial wastes. The cost of shielding and transportation militates against this method for high-level wastes. Other factors which make ocean disposal of such wastes of doubtful value are the high levels of radioactivity and heat in these wastes, the inability of recovery, and uncertainties as to the effect of these wastes on other uses of the oceans in the service of mankind.

Low and intermediate-level radioactive wastes from the industry are being disposed of in selected dumping areas in the Atlantic and Pacific Oceans. The wastes are mixed in concrete and held in steel drums. Costs vary from \$0.30 per lb near New York to \$1.00 at San Francisco.

Miscellaneous Wastes. In most industries the more significant plant wastes are satisfactorily disposed of by various methods. The normal residual waste products such as litter, dusts, chips, paper, wipes, clothing, obsolete material, and equipment furnishings, as well as structural material from plant renovation or wrecking, may be sold on the open market, lagooned locally, or dumped with normal waste materials of the community. In the atomic-energy industry such wastes are usually segregated in special containers at the plants. They are then monitored for the kind and level of activity. Material contaminated by short-lived radioactivity may be stored for decay and then be disposed of in a normal way. Where the half life of the radioisotope is long the problem is more complicated and is still unsolved.

Incinerators. Combustible radioactive material such as paper, wipes, animal carcasses, and bedding material for animals, pieces of wood or cardboard, may be disposed of by incineration. Incinerators, each different, were built to serve the AEC research and development areas—Los Alamos Scientific Laboratory (LASL), Argonne National Laboratory (ANL), and the Knolls Atomic Power Laboratory (KAPL). The operating costs for each was higher so the AEC contracted with the Bureau of Mines, Combustion Research Laboratory, for development of a suitable unit, work on which is now nearing a satisfactory conclusion.

Baling. At KAPL, wastes of the kind formerly incinerated are now being baled using an electric baler. The bales are shipped by rail to a storage area operated by the AEC in a part of the old Lake Ontario Ordnance Works near Youngstown, N. Y.

Burial. Burial of radioactive wastes—particularly solids—is widely practiced at the larger AEC installations such as the Hanford Works, the Oak Ridge National Laboratory, the National Reactor Testing Station, and at the Los Alamos Scientific Laboratory. Where conditions are favorable, burial has the advantage of low cost and effective shielding. If movement of water through the soil is slow and the distance to ground-water users large, a very substantial decay of radioactivity may take place before any source of water supply is affected. In the case of long-lived wastes, however, serious consideration must be given to the possible effect of any burial practice on the natural resources of the area.

Deep Wells. Consideration also has been given to the possibility of disposal of radioactive-waste solutions by discharge to abandoned oil and gas domes through deep

wells. The economic aspects of the problem rest on the cost of shielding and delivery to the chosen well site. This method of disposal is being explored because it has obvious advantages. The feasibility of the use of abandoned mines and caves as storage places for high-level radioactive wastes also is being considered.

Laundry Wastes. In laboratories and production areas using radioactive material, protective clothing such as rubber and leather gloves, cloth coats, caps, and shoe coverings are used extensively. When they are laundered a radioactive wash water results. It must be monitored and be disposed of accordingly.

Radioisotopes. The AEC manufactures and sells radioisotopes to hundreds of users in this country and throughout the world. They are used for research purposes in medicine, biology, chemistry, and other professional and industrial fields. The most widely used isotopes (11) are P^{32}, I^{131}, C^{14}, Na^{24}, and Au^{111}. The Isotope Division at Oak Ridge exercises a control over the users of these isotopes and requires purchasers to observe certain precautions in the disposal of radioactive wastes. The levels of activity used are such that, in general, waste disposal is not a serious problem. Current practice in many institutions is to discharge radioactive wastes to one or more holding tanks. They are monitored periodically and if activity is at or below a prescribed level the contents are released, usually to a public sewer system; otherwise they are held for decay to the prescribed levels for release.

Future Problems

Power Production. As the atomic-energy industry expands, especially in the field of competitive power, problems of profound importance in disposal of high-level wastes will be presented to plant designers and operators as well as to local and state regulatory agencies. It is obvious that, when atomic energy is supplying substantial blocks of power, the chemical processing of irradiated fuels will present problems in disposal of radioactive wastes of high level.

Site Selection. Since cost is an important factor, especially in competitive industry, it is reasonable to assume that disposal at some point near the plant will be sought. This will call for very serious consideration of the waste-disposal problem as a function of site selection. Many industries have grown to regret the lack of foresight in waste disposal when plant sites were selected.

Similar mistakes in the atomic-energy industry could be very much more costly.

Land Disposal. The ideal disposal method for high-level radioactive wastes would be to the ground at or reasonably near the chemical-processing plant. This would eliminate expensive shielding for transport to a distant site and the cost involved. Subsurface disposal in a carefully selected area offers good possibilities for heat dissipation and a relatively inexpensive method of shielding. When more is known of the ability of certain soils to retain various radioisotopes in wastes, it may be possible to depend on soils to absorb at least some of the more hazardous long-lived isotopes.

In an impervious soil, the rate of release of isotopes not absorbed by the soil should be slow so that no gross contamination of the ground water would take place. Evaluation of the potentialities of using the ground at shallow or deep elevations to receive and to confine radioactive wastes is a task for an experienced team of geologists, hydrologists, physical chemists, mineralogists, and nuclear chemists. Work along this line is in progress.

Use of Surface Waters. The surface waters—fresh, brackish, and salt—offer possibilities for dilution of low and even intermediate wastes which are to be appraised further. Dilution as a means of disposal of radioactive-waste solutions has its limits, but if used intelligently it has many possibilities for economical disposal. The suspended stream and bed loads of our waterways have the ability to adsorb substantial amounts of radioactivity without damage to their biologic cycle. Provided a downstream user of the waterways is beyond the area which would be affected by release of low-level wastes upstream, there should be no serious objection to disposal of such wastes by this method. Evaluation of the potentialities of disposal to waterways is now under investigation in the Mohawk River below KAPL.

Atmospheric Dilution. The use of atmospheric dilution in the case of the Brookhaven reactor has already been referred to. At the chemical-processing plant at the NRTS, as well as at other areas such as Hanford, Argonne, Oak Ridge, Savannah River, and KAPL, extensive meteorological studies have been made of the atmospheric dilution factors in nature.

With adequate knowledge of the meteorology of an area, decisions of basic importance can be made as to location of a critical building in relation to others, the best plans for air intakes and gaseous exhausts, the height of stacks, the degree of treatment required under designated periods of operation, dust considerations, and general weather conditions as related to installation and maintenance of facilities.

Search for Better and Cheaper Methods

The problems in waste disposal for the atomic-energy industry are many. The control of waste is currently adequate, but quite expensive. As the industry expands, especially in the power field, less expensive methods will be required if atomic energy is to compete favorably in cost with other fuels. Anticipating this situation, the AEC has placed research and development contracts with universities, private industry, the National laboratories and other federal agencies to evaluate various waste-disposal methods and particularly the extent to which the ground, surface waterways, and the air may be used to store, shield, dilute, and disperse radioactive wastes. The problem is one offering many opportunities to the mechanical engineer, not only as a specialist in analysis and design, but also as a team-worker in one of the most pressing and challenging problems facing the atomic-energy industry.

ASME Survey Questionnaire . . .

Some Questions It Answers

In the March issue of MECHANICAL ENGINEERING the complete tabulation of the returns from the 1954 ASME Membership Survey Questionnaire was presented. The survey was conducted during the summer of 1954. Each member's answers to 27 questions were recorded on an individual punch card so that it is possible to correlate the answers to one question with those to any other question.

Correlations have been made which deal with the relationship between age bracket and annual earnings (Table 1), preferences as to types of papers presented at National and Professional Division Meetings, preferences as to features in and attitudes toward MECHANICAL ENGINEERING (Table 2), formal educational status, and relationships between occupational activity and field of specialization, and between occupational activity and the industry or business in which the members are engaged. A few of these correlations are included here.

Three correlations deal with attendance at Section meetings. In the answers to the question, "How active have you been in your Section or Subsection during the past year as measured by your attendance?," almost 55 per cent of the total returns indicated nonattendance at all meetings; only 15 per cent attended more than 25 per cent of the meetings (Table 3).

Conceivably, the kind of work in which a man is engaged may be a factor in determining his interest in these meetings (Tables 3 and 4). The Survey Questionnaire listed 16 occupational activities. Taking the eight numerically highest of these occupational activities, which include over 84 per cent of the returns, it is evident that teachers and those engaged in marketing and distribution are more generally interested in Section meetings than any of the other groups, and that those in production and administration are the least interested. Examination by age groups (Table 3) reveals that the least interest is shown by young men and that the interest increases steadily up to the middle 40's. The greatest sustained interest is in the early 40's when a fifth of the group report attendance at more than 25 per cent of their Section meetings.

The age of the members also has some influence on the reasons given for nonattendance. The three reasons most frequently cited are "not interested in the program," "other commitments," and "commuting difficulties." Neither the first nor the third shows any significant trend with respect to age, but "other commitments," by far the largest of the three groups, increases steadily up to the middle 50's, starting at about 35 per cent at age 24 and younger and reaching 54.6 per cent in the 50's.

The correlation of the fields of specialization with age brackets (Table 5) is worthy of careful scrutiny as an indication of the changing impact of some of these fields on Society programs.

These are a few suggestions of the kind of facts concerning the interests and attitudes of the members in their relations to the Society and its program which the

(*Continued on page 327*)

Table 1 Age Bracket (Question 19) Related to Annual Earnings (Question 20)

	Annual earnings													
Age bracket	Under 4000	4000 to 4999	5000 to 5999	6000 to 6999	7000 to 7999	8000 to 8999	9000 to 9999	10,000 to 14,999	15,000 to 24,999	25,000 and over	Don't desire to answer	No answer	Total
24 or younger	159	312	201	30	7	1	2	4	2	...	10	10	738
25 or 26	92	357	550	177	39	7	7	12	2	...	17	19	1279
27 or 28	35	359	886	442	185	42	26	28	4	3	25	14	2049
29 or 30	25	221	891	763	345	151	67	87	13	2	33	9	2607
31 or 32	20	142	551	664	451	191	102	106	15	5	21	13	2281
33 or 34	9	77	309	389	360	244	112	168	18	10	20	11	1727
35 to 39	15	52	225	358	459	382	304	490	133	39	32	18	2507
40 to 44	8	14	63	102	220	193	214	621	229	78	27	15	1784
45 to 49	8	11	27	58	121	162	141	428	240	126	19	18	1359
50 to 54	3	8	22	48	84	125	128	463	292	182	28	19	1402
55 to 65	17	12	29	80	129	126	156	470	376	312	73	27	1807
Over 65	49	15	21	30	46	40	47	140	99	123	89	113	812
No Answer	...	...	10	2	1	...	1	3	1	...	...	205	223
Total	440	1580	3785	3143	2447	1664	1307	3020	1424	880	394	491	20,575

Table 2 Preferences for Features of MECHANICAL ENGINEERING (Question 12) Related to How Well Does MECHANICAL ENGINEERING Serve Your Needs (Question 10)

	Mechanical Engineering serves needs						
Mechanical Engineering features	Very well	Well enough	Not very well	Not at all	Undecided	No answer	Total
ASME News	96	138	51	10	25	5	325
Technical Papers:							
1 Theoretical—Analytical	252	697	811	100	124	18	2002
2 Practical—Application	837	2702	2495	237	568	57	6896
Management papers	358	966	638	87	214	31	2294
Addresses on professional and economic aspects of the mechanical engineer	167	513	357	55	109	6	1207
General interest articles	276	982	684	102	254	20	2318
Briefing the Record	147	514	286	32	82	10	1071
Technical Digest	88	356	215	22	64	4	749
Keep Informed	113	299	225	42	99	5	783
Other	25	32	83	31	14	4	189
No answer	539	927	625	155	266	229	2741
Total	2898	8126	6470	873	1819	389	20,575

Table 3 Attendance at Section Meetings

	Attended, per cent of total returns		
	No meetings	Over 25 per cent of meetings	Total returns
Kind of occupation (in order of numbers):			
Design	52.0	15.8	5810
Research, Development	55.0	13.1	2965
Administration	57.0	13.0	2405
Operation, Maintenance	55.8	16.1	1692
Marketing, Distribution (sales)	51.0	16.8	1460
Production	59.0	13.1	1224
Consulting	52.0	15.8	1104
Teaching	35.8	26.8	734
Total of all categories	54.7	15.0	20,575
Age bracket:			
26 or younger	69.4	8.3	2017
27 to 30, incl.	61.1	9.6	4656
31 to 34, incl.	55.7	15.1	4008
35 to 39, incl.	50.8	17.9	2507
40 to 44, incl.	46.5	20.5	1784
45 to 49, incl.	44.0	19.8	1359
50 to 54, incl.	42.6	18.9	1402
55 to 65, incl.	46.7	16.2	1807
Over 65	56.5	12.6	812

Table 4 Occupational Activity (Question 3) Related to Section-Meeting Attendance (Question 5)

	Section-meeting attendance						
Occupational activity	None	25% of meetings	50% of meetings	75% of meetings	All	No answer	Total
Administration	1373	676	126	143	44	43	2405
Consulting	574	347	84	74	16	9	1104
Design, application	3024	1832	398	373	146	37	5810
Estimating	214	69	17	16	8	6	330
Inspection	182	76	21	17	3	3	302
Legal (patents, etc.)	32	16	4	3	2	2	59
Marketing, distribution (sales)	747	456	105	106	34	12	1460
Operation, maintenance	945	461	104	131	38	13	1692
Placement, training	60	22	5	4	5	...	96
Production	722	329	85	59	16	13	1224
Purchasing, procurement	83	39	6	5	3	...	136
Research, development	1632	928	168	168	53	16	2965
Teaching	263	255	82	82	33	19	734
Technical writing, editing	80	52	18	16	4	2	172
Testing	308	177	21	28	16	4	554
Other	425	151	39	33	12	6	666
No answer	447	215	35	59	10	100	866
Total	11,111	6101	1318	1317	443	285	20,575

Table 5 Field of Specialization (Question 4) Related to Age Bracket (Question 19)

Field of Specialization	Age bracket: 24 or less	25 or 26	27 or 28	29 or 30	31 or 32	33 or 34	35 to 39	40 to 44	45 to 49	50 to 54	55 to 65	over 65	No Ans.	Total
Aerodynamics	18	16	25	22	15	13	14	3	6	3	1	...	...	136
Aeronautics	33	38	50	63	51	50	52	35	8	9	15	3	2	409
Applied mechanics	28	50	95	82	83	69	91	64	68	41	43	21	3	738
Chemistry	3	9	8	19	15	12	19	19	19	14	25	9	2	173
Combustion	14	28	34	51	41	38	47	52	32	56	57	18	4	472
Construction	23	41	69	115	97	75	92	66	62	68	89	22	8	827
Corrosion	...	4	9	5	7	7	7	7	4	...	7	1	...	58
Electricity	9	21	44	55	43	45	33	27	38	56	62	22	2	457
Electronics	43	40	39	44	49	35	38	24	11	8	10	2	6	349
Engineering economics	6	11	12	33	25	21	35	34	23	32	42	29	4	307
Fluid mechanics	16	32	39	40	47	32	39	23	18	11	12	...	3	312
Gas turbine power	31	51	45	58	60	37	59	13	14	14	6	4	5	397
Heat transfer	33	32	67	72	64	35	57	24	30	25	33	8	1	481
Heating and ventilating	18	43	95	131	92	55	82	61	47	46	67	19	3	759
Hydraulics	18	21	48	68	48	42	49	28	32	32	34	21	3	444
Instrumentation	26	43	79	95	86	63	69	59	36	41	39	9	5	650
Kinematics	9	8	17	18	18	14	11	6	6	4	9	3	1	124
Lubrication	4	8	23	21	15	7	15	14	16	11	15	3	1	153
Machine design	79	131	221	310	266	200	258	185	123	116	145	62	16	2112
Management techniques:														
Cost accounting	1	2	5	4	2	3	1	5	3	2	2	4	1	35
Evaluation and appraisal	6	6	18	24	15	19	33	17	10	12	4	7	1	172
Industrial relations	1	3	5	3	4	10	9	10	8	8	10	5	...	76
Organization	5	13	20	32	38	23	85	86	70	62	122	33	2	591
Plant layout and design	2	20	48	55	39	38	68	58	42	40	61	27	8	506
Prod. plan. and control	6	26	49	71	64	37	68	37	27	23	34	9	4	455
Statistical controls	3	8	15	14	7	11	7	2	3	2	3	1	...	76
Time study, methods, etc.	8	22	34	44	46	22	34	13	7	7	10	1	1	249
Other	4	11	16	15	22	17	38	37	17	14	20	5	2	218
Marine engineering	8	15	9	18	17	17	19	8	9	8	14	12	1	155
Materials engineering	8	13	18	21	9	13	26	23	11	16	13	8	2	181
Materials handling	...	14	35	47	29	34	52	33	14	20	43	6	2	329
Mathematics	...	3	...	7	3	1	1	7	5	2	3	3	...	35
Metallurgy	1	13	12	14	14	9	17	16	19	6	20	7	2	150
Naval architecture	1	2	4	6	2	5	10	2	5	1	5	...	1	44
Nucleonics	20	22	29	35	30	22	31	15	9	8	3	2	2	228
Oil and gas power	8	7	20	32	32	17	25	30	18	19	35	8	2	253
Optics	3	2	2	4	2	1	3	3	3	...	1	2	1	27
Ordnance	34	51	47	54	47	40	43	25	17	4	11	2	1	376
Physics	...	1	3	5	...	3	8	4	2	2	3	2	1	34
Piping	8	17	42	51	37	31	40	24	21	18	22	4	3	318
Power	27	58	110	134	149	96	234	157	146	195	202	70	14	1592
Process engineering	21	42	101	126	114	92	115	92	55	51	62	22	4	897
Product engineering	22	87	129	162	143	107	136	113	44	35	49	5	7	1039
Safety	2	2	8	12	11	4	13	5	10	10	16	6	1	100
Sanitary engineering	...	...	1	6	2	9	3	3	5	5	4	5	...	43
Standards	1	4	5	9	9	6	9	7	8	7	7	2	...	74
Structural design	8	22	35	25	23	16	17	8	6	9	10	3	1	183
Textile engineering	3	6	8	17	11	8	13	9	12	9	14	7	1	118
Thermodynamics	18	35	29	45	48	26	43	28	21	19	31	13	2	358
Welding	2	5	12	12	6	6	10	6	5	5	5	1	...	75
Other	57	70	109	122	123	90	120	83	43	60	60	26	10	973
No Answer	39	50	52	79	61	44	109	74	91	136	197	248	77	1257
Total	738	1279	2049	2607	2281	1727	2507	1784	1359	1402	1807	812	223	20575

survey has made available. The correlations which already have been made have been placed in the hands of Society officers and committees for their study. These by no means exhaust the possibilities. The material is available for the use of all administrative and program-making agencies of the Society.

Membership Survey Committee
C. B. Peck, Chairman
Otto de Lorenzi
T. F. Perkinson

By an ingenious plan, this single-belt conveyer performs three functions in this warehouse: (1) Transportation of goods from receiving area to storage area; (2) transportation from storage area to delivery area; (3) a simple means of segregating delivered goods by storage areas for which they are intended (United States Air Force)

Materials-Handling Trends

By James R. Bright

Lecturer, Graduate School of Business Administration, Harvard University, Cambridge, Mass. Member ASME

In 1953 the author was invited by The Institution of Mechanical Engineers of Great Britain to deliver the 1953 James Clayton Lecture on the subject of materials handling. For eight months prior to the lecture, he toured this country to study handling in both large and small firms. As chief editor of the magazine, *Modern Materials Handling*, he obtained ideas from the leading American manufacturers of materials-handling equipment. From this wealth of information a comprehensive paper was prepared to cover five fields: (1) The significance of materials handling in economic life; (2) the objective of materials handling; (3) how American industry is organizing for materials handling; (4) methods of solving materials-handling problems; (5) the significant trends in materials handling. This presentation is a brief extract from the complete paper.[1]

MATERIALS handling is the most universal physical activity of all mankind, and the act of handling things is the common denominator of our economic life. We cannot turn an eye on any of man's major endeavors without seeing movement. Yet industry's attitude has been astonishing. For thousands of years man has concentrated on improving the techniques of making things—that is, creating form utility—but he has given relatively little attention to improving techniques of moving things—creating time and place utility.

The Science of Transportation

To be sure, he has engineered in two areas with considerable success. For example, in the science of transportation, one cannot deny that engineering miracles have been performed. The other area is the science of motion study. As a result, we have a fairly well-planned and scientific approach for moving things across miles, and another equally good for moving things within arm's reach. Yet, the gap between has been practically ignored. The job of "short-range transportation" has gone begging, barring a few exceptions. Although our production operations inevitably require transportation through a sequence of work stations, we have concentrated on the former and almost ignored the existence of the latter! As a result, all of us are paying for the ridiculous anachronism of sandwiching 1954 production technologies between transportation methods of unknown—or unconsidered—efficiency.

If manufacturing efficiency can be described as actual production operation time divided by elapsed time in a plant, what sort of efficiency do we find? Study of a recent specialty item showed that from receipt to shipping the materials were in the plant 240 hr. Slightly more than 10 hr were devoted to actual processing of the material. This is a manufacturing efficiency of 4 per cent. No imagination is required to realize that this reflects an expensive investment in inventory which in turn demands excessive storage and handling facilities. This example is not extreme; it is an outstanding performance compared to routine production. At a recent seminar on this very subject, operating men were urged to check some of these things in their own plants and see how large the handling activity in their jobs was. There was considerable amazement when the results of these studies were exchanged.

As a typical example, the window frame for an automobile door consisted of five parts requiring 37 production operations. In performing these 37 operations the five parts were handled a total of 208 times. There were 198 temporary storages. This was not out of line with the experiences in other types of plants represented; the average ratio of handling operations to production opera-

Contributed by the Materials Handling Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] Copies of the paper may be obtained under the title of The James Clayton Lecture, "How American Industry Is Attacking the Problem of Materials Handling," from ASME Order Department, 29 West 39th Street, New York, N. Y.

tions was about 7:1. Only in one case was it as low as 3:1.

A more precise 1948 study made by Westinghouse showed that 26 per cent of the man-hours in all plants were paid for as materials-handling labor. This did not take into account the vast amount of handling done by production operators who moved materials to and from their work stations. The biggest single activity was not machining, nor was it assembly. The biggest single job was movement. It was discovered that the average part was handled approximately 100 times. Therefore one ton of products shipped meant at least 100 tons handled, to say nothing of the handling associated with supplies and scrap.

One member of the seminar found that the manufacturing cycle efficiency of a standard gear in his plant was 0.021 per cent. Operation time totaled 37 min, but the gear material was literally months in getting through the plant!

These are not horrible examples. They reflect everyday accepted practice in the vast majority of firms.

The Changing Scene

As a result of such studies, materials handling is beginning to receive great emphasis. Thousands of firms are beginning to recognize that materials handling is a major aspect of production operations, and an extremely profitable one for methods improvement. Many firms have appointed materials-handling engineers to specialize in methods improvement in this area or/and materials-handling managers to operate materials-handling facilities on an integrated plantwide basis.

The American Materials Handling Society has grown since 1949 from six small chapters to over 30 chapters here and in Canada.

A biannual Materials Handling Exhibition has become one of the largest industrial trade exhibitions in America.

Some 70 colleges are teaching materials-handling courses in one form or other.

In 1954 the author established the first comprehensive materials-handling training conference on an industrial level. This is a two-week program to cover the basic training of materials-handling engineers, and interest is such that it will become an annual affair.

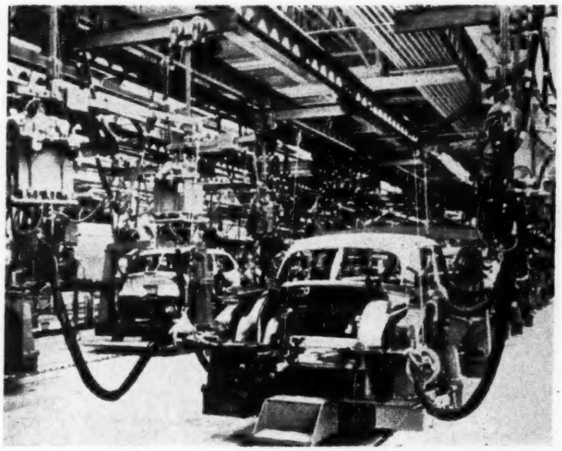
Materials handling at last is receiving a more reasonable share of attention from production managers and top management. It has become clear that the key to increased productivity in thousands of plants is the continuous flow of materials through the plant on as mechanical and/or automatic a basis as is economically feasible.

As one plant engineer said, "Our new plants are built around new concepts in handling; there's little that's new in manufacturing or forming."

Attacking the Handling Problem

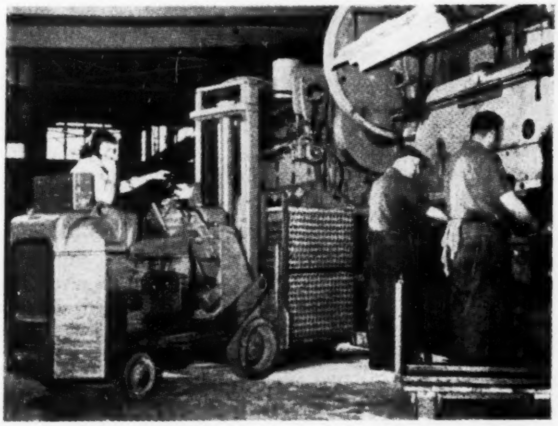
The tremendous gains in productivity come about in many ways. The objectives of materials handling might be described as follows:

To Reduce Costs. This is the most obvious reason for mechanizing handling operations; but there is an unsuspected and often overlooked aspect of this. Sometimes firms concentrate on the reduction of handling costs as their big objective. Such an attitude and approach often limits the potential savings tremendously.



In this new automobile plant, some of the production machines move with the work on the conveyer line to eliminate need for slowing of the conveyer (De Soto Motor Corporation)

Unit loads provide protection with very little packaging. Imagine the packaging and handling job if these ceramic insulators were treated as separate pieces (Brainard Steel Co.)



Radio has increased the efficiency of truck operation by 30 to 100 per cent. Two-way radios are essential in many plants because they are so large. For instance, a plant at Fort Worth, Texas, is one-and-a-half miles long (Towmotor Corporation).

A ninety-station intercom system enables the master-control room to arrange conferences "on the air" in a matter of minutes. Troubles are dealt with promptly and with minimum of paper work and movement. A wire recorder records the radio production reports when the control people are engaged elsewhere (*Factory Management and Maintenance*).

The overhead handling system covers all of the dispatch area in this automotive plant (De Soto Motor Corporation)

The ultimate objective of mechanization is to reduce unit production cost. This often is quite different from reducing materials-handling costs. It may require raising the handling cost. This consideration throws an entirely new light on the proper approach.

As an example, consider the new concept of handling and storing steel billets developed at the Timken Roller Bearing plant, Canton, Ohio. This handling program is based on the straddle carrier, controlled by two-way radio, and storing material in open fields at distances up to a mile and a half from the plant. The handling costs were tripled, but the unit production costs were much reduced. The speed of moving materials to and from the production operation is such that the total output of the finishing mill has increased about 20 per cent. It has paid handsomely to increase the handling cost in order to achieve the main economic goal of reduced production cost. We should never lose sight of this when tackling a handling problem.

To Increase Capacity. Many a handling system benefits the user by enabling him to maintain the same production in less floor space, or to increase output of a given space. The amount of material moved in a given time can be increased. This may save money through reduced demurrage, reduced spoilage of material, better customer service, smaller inventory, smaller space requirements, etc.

To Increase Safety. Over 25 per cent of all industrial accidents occur in materials handling. Mechanized handling can and does reduce this. In addition, it greatly decreases the day-to-day drudgery of many jobs.

Reduction in damage and improvement in the quality of the product has resulted from many handling installations.

To Increase Salability. Modern handling often improves sales because it increases the quality of the product, or delivers it in a form—perhaps in bulk, perhaps in a unit load, perhaps in a more consistent and uniform quality, that was not possible under the old handling methods. Often the increased speed of delivery is a sales asset.

Significant Trends in Materials Handling

It is clear that we are in the midst of a great wave of materials-handling improvements, and certain developments stand out. No claim is made that the following is a complete list but it does cover some of the more obvious trends:

Growing Reliance on the Conveyer. In hundreds of plants some form of the conveyer has become the heart of the plant's activity. It is no longer an accessory. It is the basic production machine. The newest plants are built around the conveyer. The conveyer can be used not only to transport materials from operation to operation, but also to fix the sequence of operations and start production actions. It can determine their duration, and stop them.

In some plants the conveyer is being introduced as a storage device, so that the flow of raw materials from storage to production is just as mechanized and consistent as production itself. In other words, intermittent delivery to a continuous flow line often does not make economic sense. The new storage-conveyer installations are proving this.

The Impetus Toward Automation. The author believes that it can be argued successfully that automation is not the least bit new. Progress toward "push-button" operations has gone far in the chemicalindustries, the food-processing field, and in many other activities. However, the word is such an apt description of the philosophy of continuous and automatic flow that it has spread like wildfire. Automation has been adopted as an expression meaning an organized effect to achieve a high degree of mechanization. It calls for product selection, product design, scheduling, planning manufacturing and handling methods that will maximize economical product runs. Automation might be de-

Television has great potential in materials handling. In this experimental installation, made while field-testing equipment, the 45-cu-yd bucket is so far from the operator that he cannot see whether it is full. A TV camera is mounted on boom (Hanna Coal Company and Radio Corporation of America).

The television image is transmitted to the operator's cab so that he can see how to maneuver to get a full scoop. If machine utilization is increased as much as 30 per cent, effective use of that percentage of the machine's cost is gained (Hanna Coal Company and Radio Corporation of America).

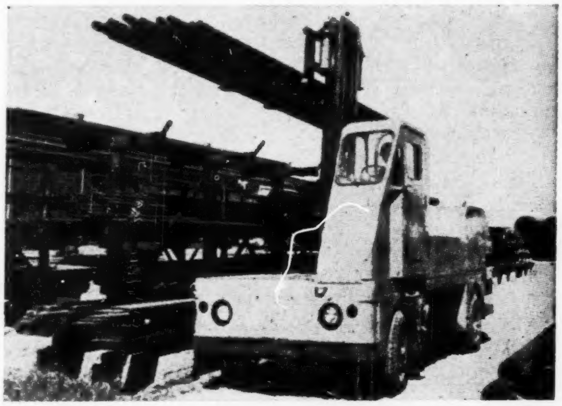
scribed as the philosophy of integrating the factory into one giant machine.

Although many people believe that only the mass-production industries can make progress in this direction, this is not so. As an example of semiautomation, consider the homemade railroad tie-handling system, in which semipush-button unloading of railroad ties, semiautomatic stacking, mechanized movement into storage have been developed most ingeniously. (This subject is discussed in detail in the original paper.)

Extension of Unit-Load Concept. We need not spend many words on this, since all of us have seen the unit-load idea growing by leaps and bounds in every field. One recent important aspect is that we are just beginning to study the unit load itself, with the idea of determining its optimum size for the conditions in question. There is some belief that the optimum size for a unit load may be the size needed at the point of issue so that all breaking down will be eliminated prior to use. Thus the vendor would make up the unit load to the customer's specifications, and this would be handled as a unit until it hit the production line.

The Lift Truck as the Universal Handling Machine. It is questionable whether we should still use the term "fork truck," since it scarcely describes the thousands of ingenious modifications that have been made of this vehicle. Hundreds and hundreds of special attachments have been developed to enable it to grasp bales, boxes, crates, drums, tanks, rolls, coils, bulk materials, flat sheets, bar stock, and so on. These attachments are aimed at eliminating pallets or similar accessories and to facilitate manipulation of the loads. The trend is toward creating a kind of giant hand, with all the flexibility of a human hand. Because the fork truck has complete freedom as to speed, path of movement, timing, because it can lift many types of things, because of its relatively low cost and its ever-growing ability to manipulate loads as well as lift them, it is becoming the universal handling device.

Engineered Containers. We are beginning to appreciate that the container may be the heart of the handling system. It involves the mass movement of materials between use points, stacking in unit loads, and the design



The "Traveloader" is perhaps the only completely new materials-handling vehicle in recent years. It combines: (1) An over-the-road vehicle; (2) a self-loading vehicle; (3) the advantages of fork lifting (Baker-Lull Corporation).

of an ideal way to get the particular item in and out of the container. Consequently, the engineered container is opening up new frontiers in process design.

Mechanization of Communications to Speed Movement. What controls the speed of material movement through a plant? Some have more than a suspicion that it is the speed at which the paper work moves, not the speed at which the equipment is capable of processing material or moving it. The astounding results obtained by the application of mobile radio to fork trucks, yard cranes, straddle carriers, yard locomotives, and other industrial handling devices seem to indicate that we have been overlooking something. The ability to control, through verbal discussion from a single point, has produced increases in efficiency anywhere from 10 to 200 per cent. Deadheading has decreased, emergencies are dealt with on the spot, production data are delivered as current events, not "history four days old," and much expensive and unnecessary paper work is eliminated.

Industrial television is coming into use to control handling operations from a distance. The office dictating machine, in a few instances, has demonstrated that

it has possibilities as a production-control device. The integrated control panel, with flashing lights to indicate the status of material in bins and hoppers, the amounts of material on the conveyer lines, safety indicators, breakdown indicators, and so forth, is giving many a plant a centralized control point. In effect, it provides a living flow chart for production operations.

Continuous Weighing, Mixing, and Blending. These have existed for a long time. However, new impetus has been given to this field and far more of the bulk-handling industries are shifting from batch operations to continuous-mixing operations. This implies, of course, continuous weighing and continuous metering, both of which are being done with great success.

Expansion in Overhead Handling Systems. The monorail, the trolley conveyer, and the stacker crane are spreading rapidly. Many assembly conveyers are now being based on the overhead trolley conveyer instead of a floor-mounted chain conveyer. Advantages are ability to provide the optimum working heights at successive production points, keeping the floor free of clutter, making use of space formerly wasted overhead, and releasing floor space formerly occupied to people or to production machinery. Overhead stacking systems based on the stacker crane will go to tremendous heights, which are impossible with fork trucks.

A fascinating and important development is the automatic dispatch system based on the monorail. Special carriers running on these rails and properly controlled move from building to building or machine to machine with no manpower, and with the utmost safety to materials. Automatic dispatch systems can be made selective, so as to go to any one of a number of points as desired. They have been made to search out empty or full locations in storage or processing, and act accordingly with the material.

Growth of Yard Storage. All over America we are running out of space. Buildings are so expensive that much more storage is being done outdoors. This means that the mobile yard crane has become an important handling device in many an industrial plant.

In addition, the lumber carrier or straddle carrier is growing in application. We are beginning to realize that it is a self-loading truck which enables one man to pick up, move, and unload as much as 22 tons. Since it can be unloaded or loaded in a few seconds and can travel at highway speeds, it has tremendous potential where truckloads must be moved, say, up to 25 miles or so.

Mechanization Pays Off

It is clear that a new wave of energy, imagination, and investment is being applied to mechanization. The heart of this effort is directed at moving materials economically and under control—automatically where practical, mechanized as much as feasible—with visual and verbal remote control where necessary. These efforts have their rewards in improved product quality, lower production cost, happier working conditions for labor, and greater reliability and uniformity of the manufacturing process.

Tomorrow's Approach. The management that wants to tackle production improvement through better handling must do three things:

1 Recognize the importance of handling in its operations.

2 Centralize the handling activities under one vigorous authority, charged with both operating and improving handling procedure.

3 Use imagination in conceiving production procedures and arrangements that will integrate the factory into one smooth-running machine.

Plastics Developments, 1953-1954

(*Continued from page 320*)

104 "Plastics in Aircraft and Guided Missile Structures," by W. E. Braham, *Plastics* (London), vol. 18, October, 1953, p. 350.

105 "Plastics Armor for Aircraft," by L. J. Constanya, *Modern Plastics*, vol. 31, September, 1953, p. 93.

106 "Plastics in Primary Structures," by D. M. Hatch, Jr., and J. Steinman, *Modern Plastics*, vol. 30, August, 1953, p. 89.

107 "Reinforced Plastics in Complete Structures," by W. E. Braham, *Modern Plastics*, vol. 31, September, 1953, p. 96.

108 "New Techniques in Fabricating Honeycombs," by R. C. Steele, *Modern Plastics*, vol. 31, February, 1954, p. 101.

109 "Sandwich Materials," by K. Rose, *Materials and Methods*, vol. 39, March, 1954, p. 39.

110 "Effect of Certain Fabricating Variables on Plastic Laminates and Plastic Honeycomb Sandwich Construction," by B. G. Heebink, F. A. Werren, A. A. Mokaupt, Forest Products Laboratory 1843, November, 1953.

111 "Determination of Elastic Constants of Orthotropic Materials With Special Reference to Laminates," by R. K. Witt, W. H. Hoppmann, R. S. Buxbaum, ASTM Bulletin 194, December, 1953, p. 53.

112 "Arcing Performance of Plastics Insulation," by T. J. Martin and R. L. Hauter, *Electrical Manufacturing*, vol. 53, April, 1954, p. 102.

113 "Evaluating Dielectric Properties of Plastic Laminates," by S. W. Place, *Electrical Manufacturing*, vol. 54, October, 1954, p. 95.

114 "New Phenolic-Glass Laminates for Elevated Temperature," by J. B. Campbell, *Materials and Methods*, vol. 38, November, 1953, p. 89.

Coatings and Adhesives

115 "Uses and Potentialities of Sprayed Vinyls," by J. B. Singer, *Plastics* (London), vol. 18, September, 1953, p. 309.

116 "Plastics vs. Corrosion," *Modern Plastics*, vol. 31, September, 1953, p. 83.

117 "New Jobs for Sprayed-On Plastics," *Modern Plastics*, vol. 31, October, 1953, p. 93.

118 "Microstructure of Paint Films," by W. von Fischer, et al., *Industrial and Engineering Chemistry*, vol. 46, March, 1954, p. 572.

119 "Flame Spraying of Polyethylene," by R. A. Wiese, *Modern Plastics*, vol. 31, February, 1954, p. 122.

120 "Sprayed Plastic Coatings," by R. Dickson, *British Plastics*, vol. 27, May, 1954, p. 171.

121 "Selecting Protective Coatings for Metals," by J. B. Campbell, *Materials and Methods*, vol. 38, August, 1953, p. 109.

122 "Properties, Processing and Uses of Metal Bonding Adhesives," by O. W. Loudenslager, *Rubber Age*, vol. 73, August, 1953, p. 641.

123 "Adhesives Advance," *Modern Plastics*, vol. 31, November, 1953, p. 102, and December, 1953, p. 93.

124 "Metal-to-Metal Bonding," by G. Epstein, *Modern Plastics*, vol. 31, December, 1953, p. 93.

125 "Adhesive Bonding of Various Metals as Affected by Chemical and Anodizing Treatment of the Surface," by H. W. Eickner, Forest Products Laboratory Report 1842, June, 1953.

126 "Shear, Fatigue, Bend, Impact and Long-Time-Load Strength Properties of Structural Metal-to-Metal Adhesives in Bonds to 24S-T3 Aluminum Alloy," by H. W. Eickner, Forest Products Laboratory Report 1836, June, 1953.

127 "Mechanical Testing and Inspection of Structural Adhesives," by H. Grinsfelder, B. Coe, R. P. Hopkins, ASTM Bulletin 194, December, 1953, p. 62.

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Associate Editor*

Automatic Electronic-Component Assembly

An automatic assembly machine for attaching diverse electronic components to printed circuits has been developed and sold by the Mechanical Division of General Mills, Inc., Minneapolis, Minn., to International Business Machines Corporation.

Called "Autofab," the machine will be used by IBM in production of printed-circuit subassemblies for the giant air-defense computers the firm is building for the U. S. Air Force. Each of these computers requires thousands of these "building-block" circuits.

Although the first Autofab machine will be used for national defense, it is immediately applicable to industrial use.

General Mills scientists and engineers see in their machine, for example, wide utilization in commercial mass production of radio and television sets.

The Autofab machine, General Mills says, achieves stepped-up output at lower cost and with increased quality. Its estimated capacity is more than 200,000 assemblies a month—based on a 40-hr week. Three people—two operators and a supervisor—can operate the basic Autofab machine.

The principal parts of Autofab are a feeding mechanism for the printed-circuit base plates, 24 attaching heads complete with controls and components feeders, a conveyer system for moving base plates along the assembly line, a positioning mechanism for locating base plates under the attaching heads, and interlocks to insure proper sequencing.

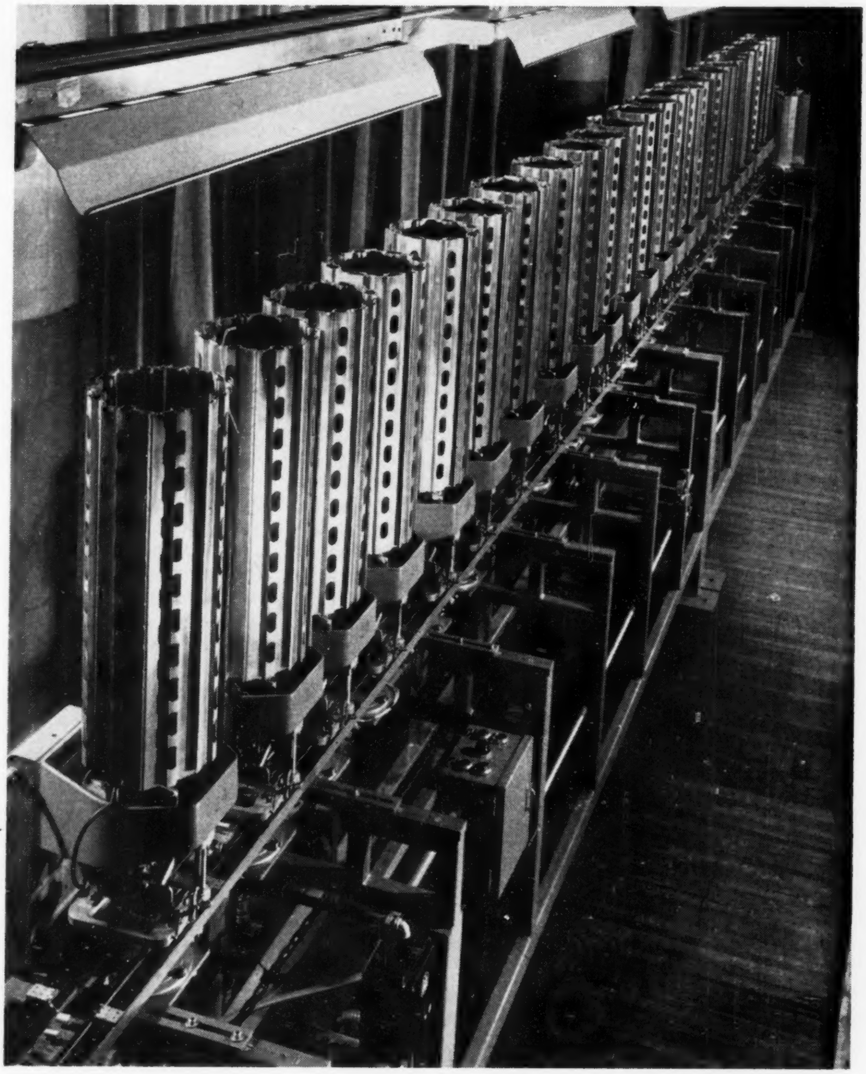


Fig. 1 This is Autofab, the automatic electronic assembly machine developed and manufactured by the Mechanical Division of General Mills, Inc., Minneapolis, Minn. It inserts from 1 to 24 electronic components—assorted resistors, capacitors, pulse transformers, and diodes—into printed-circuit plates. Normal speed is 20 assemblies a minute, which is nearly 10,000 in an 8-hr day. The first Autofab machine is working for defense at International Business Machines Corporation to speed production of huge air-defense computers, but others are soon expected to be in use by radio and television manufacturers.

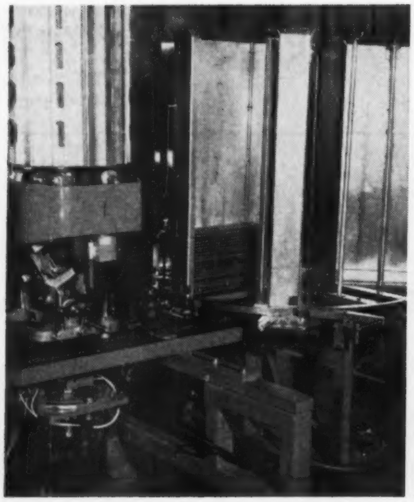


Fig. 2

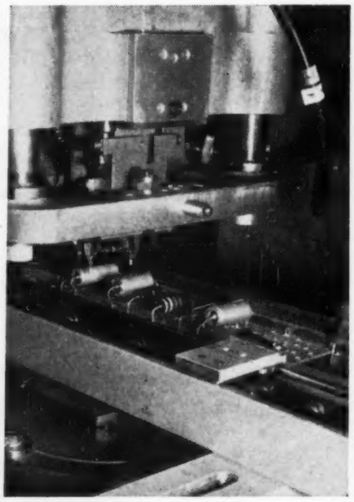


Fig. 3

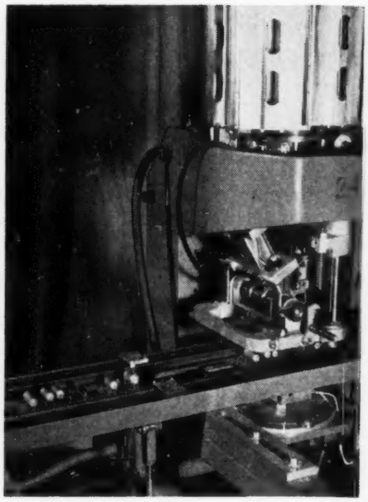


Fig. 4

Fig. 2 shows the beginning of the Autofab automatic assembly line. Printed-circuit cards feed down onto the conveyer from the turret at the right. As they move down the line each stops in turn under each of 24 attaching heads (No. 1 shown here) to receive assorted electronic components. The circuit card and component turrets all automatically rotate as a magazine or container empties, bringing full ones into operation. Empties then are refilled while the machine remains in operation. In Fig. 3 the action of the Autofab machine is stopped during insertion of a small resistor. It shows a partially assembled plastic-printed-circuit card about to receive the resistor, the leads of which are already bent to the proper spacing. Fig. 4 shows assemblies rolling off the end of the line. In this case Autofab has inserted 11 assorted components.

Power is supplied by a conventional electric motor and compressed air at normal factory pressure.

A companion machine to prepare and load components is under construction. The components, except polarized ones, are simply poured from the package into a hopper. The preparation machine straightens and trims leads, puts on wrap-around sleeves (for the IBM machine), and loads components into magazines that are simply hung on the attaching head turrets.

Operation

In operation the printed-circuit feeder is loaded with base plates (capacity 400 plates with protruding lugs—more without lugs) and each of the 24 heads is filled to capacity (average 600) with separate components. All the attaching heads, controlled by a camshaft, operate simultaneously. As each printed-circuit plate reaches a position under an attaching head, the conveyer system stops momentarily, the head attaches its component, and the conveyer resumes its progress. When the plate reaches the next head, the same operation is repeated until all 24 separate components have been attached.

For circuits carrying less than 24 components, only as many heads as are required are used. The system is completely flexible in this regard. It is not tailored to a single circuit. IBM, for example, plans to use the machine for several hundred different assemblies.

After completing the full cycle, the fully assembled unit is fed onto a conveyer for the next operation, either inspection or automatic dip soldering. General Mills is building an automatic dip-soldering machine designed by IBM as a necessary companion to the basic machine.

Loss of operating time is eliminated by use of multiple magazines on the base-plate feeder and the attaching heads. Magazines are turned automatically so that, when one is emptied of components, a full chamber immediately moves into operating position. The empty magazines then can be filled while the machine is running.

Quality control and avoidance of waste are achieved through uniformity in the attachment process and by automatic stoppage of the machine upon improper or incomplete attachment of any one of the separate components. When this occurs—a head may have exhausted its component supply and not been refilled through oversight on the part of the operator—a warning light flashes on that particular operating unit. Because of the signal no time is lost in locating the trouble and because the machine stopped no material is lost through defective assembly.

Not only does the Autofab machine afford maximum safety in the assembly process, but its operating parts are easily accessible and require a minimum of maintenance, General Mills engineers say.

Various Adjustments Available

The machine can be adjusted to accommodate printed-circuit plates of varying lengths and widths—either dimension variable from 2 in. to 10 in. Minor design changes would permit use of other sizes. The attaching heads are interchangeable (attached by two bolts) and can be located in any station position in the line. They weigh only 25 lb, which permits them to be carried easily by one man.

There are no shock loads or abrupt changes in velocity imposed on the circuit cards or the components. All attaching forces are applied directly to the component leads and none to the bodies, so damage to components is eliminated. The methods of shaping leads can be used on a wide range of components without major

adjustments. Several modes of attaching components to the circuit cards are available—flat on the board with a "stand-off" from the board, or mounted in holes spaced closer together than the length of the component.

Polarized components such as diodes, capacitors, and pulse transformers can be handled with proper orientation, because it is not possible to put magazines into the turrets backward.

Sandpaper Maker

A SANDPAPER-MAKING machine, three city blocks long, is now in operation at Minnesota Mining and Manufacturing Company, St. Paul, Minn.

The huge 976-ft-long plant, said to be the world's largest, was built to apply advanced technology to the manufacture of coated abrasives, and represents the combined technical skills of the company's engineering, research, and production staffs.

The unique structure is actually a single manufacturing unit with a shell built around it. Research personnel and management determined that the plant have built into it the flexibility and controls necessary to make what the company calls "coated abrasives of tomorrow."

The firm's blueprint for coated abrasives of tomorrow is built around the continuous growth and development of coated abrasives throughout industry, and the increased need for new construction in glue-bonded abrasives, and the ever-expanding field of resin-bonded abrasives.

The new maker will enable the company to take advanced pilot-plant research and development and apply it to the actual manufacture of coated abrasives.

Electronic, nucleonic, mechanical, and air equipment in the maker control machine speeds, curing temperatures, bond viscosities, and other variable factors. Penetrating radiation in the form of beta rays measures the uniformity of coating thickness and coating weights as the continuous web of coated abrasives passes through the maker to the drying tunnels.

These devices were developed to insure continued improvements in constructions and consistency in quality,

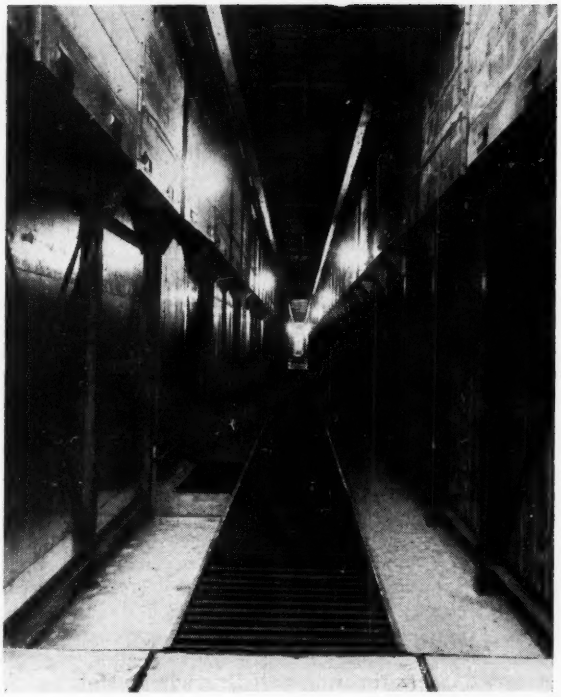


Fig. 6 Giant curing ovens as this extend for some 900 ft atop the new sandpaper maker. Here the webs of coated abrasives are cured and dried before being converted into sheets, disks, belts, and the like.

which are major factors in forwarding the use of coated abrasives for grinding and finishing in industry, the company said.

A battery of recorders keeps a continuous check on each operation in the manufacturing process.

The size and radical shape of the maker were largely determined by its massive curing ovens—topped by giant exhaust vents and make-up air heaters—which extend for some 900 ft along the top of the plant's first-level warehouse.

The warehouse is the key to a modern materials-handling system.

From the warehouse the minerals and raw materials for adhesives are elevated to the top of the maker, where they begin their flow toward the finished product. The minerals are gravity-fed to the coating chambers and adhesive components are placed in large mixers, then piped to the manufacturing level. Meanwhile, minerals and adhesives for the next production run are already "on deck" to facilitate a swift change-over

Fig. 5 This is the world's largest sandpaper maker, built by Minnesota Mining and Manufacturing Company, St. Paul, Minn., to apply advanced technology to the manufacture of coated abrasives. The plant—which is a machine with a shell around it—is 976 ft long.

of the making run to another type of coated abrasive.

The main floor of the warehouse—underneath the maker's machinery—is connected by tunnels to drum-stock storage levels of the converting buildings in the company's St. Paul manufacturing group.

In addition to railroad trackage, one end of the maker has four truck platforms, each of which has an adjustable ramp, which can be raised or lowered to coincide with the height of a truck's bed or tail gate.

Methods Engineering

Within ten years 75 per cent of all important management decisions by major American companies will be the result of mathematical computations, it was predicted recently, by Harold B. Maynard, Mem. ASME, management consultant, and president of Methods Engineering Council of Pittsburgh, Pa. Mr. Maynard spoke at the Engineers' Club in New York, N. Y., where he reviewed new developments in industrial management.

In addition to reporting on "mathematical management," he disclosed details of a new system of universal standards for use in measuring labor costs in construction work of all kinds, electrical repair, and maintenance work. The new system, he said, will revolutionize the field and reduce labor costs as much as 30 to 40 per cent. Accurate cost estimating will be made possible for the first time by the application of these standards, Mr. Maynard declared.

He also outlined a new method of accelerating production through a unique training concept. This method "will meet with the approval of labor because it involves no speedup, but merely teaches workers to do their jobs better through more precise training and better original selection," he said.

Mr. Maynard said that calculations made possible through "operations research," a mathematical system refined through the use of electronic computers, have recently demonstrated their uncanny ability in industry. Originally, they proved their worth in plotting anti-submarine warfare in World War II.

"The mounting success of this technique of linear programming makes it apparent that, by 1965, three out of every four major management decisions made in leading U. S. companies will be aided by, and be the result of, mathematical calculations. Mathematics will actually be making up the minds of tomorrow's executives."

Many Variables in Decision Making

In any kind of management, he continued, there are many variables, frequently hundreds, which must be taken into consideration in accurately making decisions.

The variables are assigned specific mathematical values by the methods engineer, and then these values are fed into an electronic computer, which then comes up with "one best answer."

Substantial and practical results have been obtained for a number of companies through the use of this method, Mr. Maynard pointed out. An automobile-parts manufacturer operating two widely separated plants, wished to know how to assign production to assure maximum profits by minimizing manufacturing and distribution costs. The firm was advised on its programming, so that a quarterly profit increase of $110,000 was achieved on $2,000,000 of sales.

A hardware manufacturer could sell more than he could produce. The firm was following the policy of concentrating sales in nearby markets and purchasing for resale in more remote markets. Management of the firm was interested in knowing what to make, what to buy, and where to sell what to maximize profits.

$350,000 Increase

It was mathematically established that it was more profitable in certain instances to ship its own production to distant points and to resell purchased goods nearer home. A resultant annual $350,000 increase in profits is predicted, Mr. Maynard said.

An oil and grease-blending firm, about to purchase a $250,000 warehouse, was advised against it as the result of mathematical computations. The company was shown how to balance manufacturing and storage facilities to eliminate the need for more space and, through the establishment of proper manufacturing lot quantities, how a 10 per cent increase in sales could be realized with existing facilities.

New Standards for Maintenance Construction

"Under our methods-time-measurement system, we have made it possible to establish universal standards for work ranging from carpentry repairs to construction of a factory," Mr. Maynard stated. "Such variable tasks as electrical and construction work and repairs can be precisely measured in a few moments of calculation."

Plant operating costs can be cut from 30 to 40 per cent by being able to estimate repair and maintenance bills accurately, he said. A plant with a labor force of 3000 can save $250,000 a year.

By using mathematics, the costs of major construction jobs can be ascertained in advance, with an absolute minimum plus or minus allowed for error, he continued.

Every element in the most complex building job can be measured and, barring the elements of nature, the total can therefore be known.

Faster Training

"The master training concept (MTC) will enable workers to achieve substantially greater production through means which are acceptable to unions," Mr. Maynard said. "MTC first assists management and unions in selecting the best workers for various jobs.

"The workers then are given accelerated training of greater effectiveness than is generally found today, and this results in higher production per capita. The worker is doing a better and more satisfying job for himself, his company, and his union. There has been union resistance to work-measurement techniques and incentives but, because of its broad benefits to everyone concerned, MTC may well remove these objections."

Mr. Maynard expressed the opinion that techniques such as these would prove significant in solving the U. S. "tariff problem," which he described as more likely of solution by increasing productivity than by increasing tariffs. Methods which will permit our economy to become truly competitive with nations having lower standards of living and labor costs may make tariff considerations academic, he contended.

Fig. 7 An apprentice mechanical engineer is shown operating a machine which measures the tensile strength of an aluminum alloy at the Mechanical Engineering Research Laboratory at East Kilbride, near Glasgow, Scotland

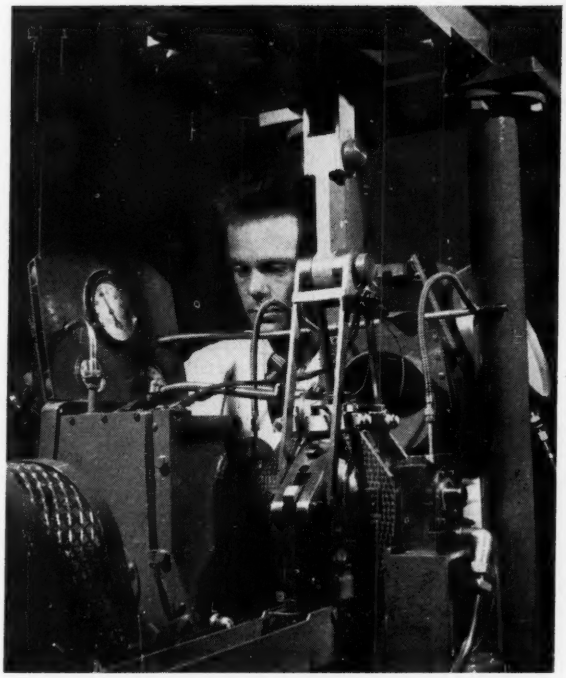


Fig. 8 Research in the field of mechanical engineering is being carried out in Britain's new Mechanical Engineering Research Laboratory. Here ball bearings for use in gas turbines are being tested at high speeds.

British Mechanical-Engineering Research

A NATIONAL research center for mechanical engineering is being established by the British Government in East Kilbride, near Glasgow, Scotland, according to an article by A. G. Thomson received from British Information Services. This research station will serve industries whose combined exports have a value of more than \$2,083,000,000 a year. The cost of the buildings so far projected is expected to exceed \$5,600,000.

The new laboratory is part of the Department of Scientific and Industrial Research, which was started in 1916 to promote and organize scientific research with a special view to its application in trade and industry. The DSIR, which is Government-financed, controls 14 research organizations, each concerned with a specific field of activity. It also encourages research in industry by the promotion of research associations and sponsors long-range fundamental work at universities.

For many years Britain's center of mechanical-engineering research under Government auspices was the Engineering Division of the National Physical Laboratory. Because of the critical importance of mechanical engineering to almost every industry, a committee was appointed by DSIR after World War II to consider how essential requirements of research in mechanical engineering could be extended. In accordance with the committee's recommendations, the Mechanical Engineering Research Laboratory (MERL) was established in 1947.

Metal Fatigue

MERL's latest report records substantial progress in the construction and equipment of laboratories and ancillary buildings at East Kilbride. The research station already has a total staff of more than 300, including more than 120 scientific and experimental officers, and this figure will eventually be doubled.

One of the laboratory's seven main divisions is concerned with the properties and strength of materials. The problems at present being investigated are mainly those associated with fatigue and with the effects of high temperatures on mechanical properties. The subject of fatigue of metals has lately come into prominence as a result of the inquiry into the Comet aircraft crashes, but it has long been a limiting factor in the design of engineering components, especially for high-speed operation. The fundamental and applied research in this subject at the National Physical Laboratory is being continued and intensified at East Kilbride with the object of enabling the designer to produce components which are both safe and economic.

To improve the efficiency of jet engines, steam turbines, and other heat engines, there is a demand for materials capable of functioning satisfactorily at temperatures much higher than those at present being used. A group of workers at the research station is therefore studying the effect of complex stress systems, such as occur in these applications, on the mechanical properties of metals at high temperatures.

The design and manufacture of hydraulic machinery is among the oldest and most important of the mechanical-engineering industries, but flow conditions in individual components of hydraulic machines, such as water turbines and pumping machinery, are often complex and the basic principles are insufficiently understood. Problems of fluid mechanics will be studied at East Kil-

bride with the aid of models in a hydraulic machinery laboratory, now almost ready for occupation, which will be among the finest laboratories of this kind in the world.

Lubrication

Wherever there is machinery, there are bearings to be lubricated and parts on which wear and corrosion must be minimized. Although there has been extensive research on lubrication, much of the work has been empirical and presents little guidance to designers faced with new problems. MERL carries out fundamental research on lubrication, as well as research into modes of lubrication and the occurrence of wear in specific machine elements, such as high-speed ball bearings for gas turbines. Observations made in an electron microscope are leading to consistent explanations for lubrication and wear processes.

Metal Forming

In the course of centuries, man has acquired a vast store of practical experience in cutting and forming metals, but only in recent years has there been systematic research into the manner in which metals behave during these processes. MERL's Plasticity Division is studying plastic deformation in commercial processes, such as extrusion and forging, as well as deformation of material when cut by a tool, which presents difficult problems. Other workers are attempting to gain basic knowledge of plastic behavior by studying the movement of dislocations in crystals—gaps in the orderly array of atoms in the crystal.

Recent developments in such fields as gas turbines, atomic energy, and power generation, call for heat transfer under unprecedented conditions. The future development of several branches of engineering depends on a knowledge of basic thermodynamic properties of various fluids and refrigerants over ranges of temperatures and pressure far beyond those already known. One of MERL's seven divisions is, therefore, concerned with heat transfer and thermodynamics. A heat-transfer laboratory is under construction and should be available in 1956.

The remaining division is engaged in research on the characteristics and functioning of the many mechanisms and mechanical devices used in engineering practice and production machinery, the development of exact measurement and measuring devices, and the elimination or suppression of noise in machinery of all kinds. Special attention is being paid to gears, and automatic machines for measuring errors in gears and in gear-hobbing machines have been designed. These will help in the production of more accurate gears for motor vehicles, aircraft, and ships.

Atomic Explosions Versus Weather

Atomic explosions have "insignificant" effects on weather, two Weather Bureau scientists declared during the 135th national meeting of the American Meteorological Society at New York University, New York, N. Y.

Weather Bureau research into the subject was described by Dr. Lester Machta and D. Lee Harris. The four-day AMS meeting was held as part of the observance of NYU's College of Engineering Centennial, whose theme is "Teaching and Research Build the Future."

The United States has been getting warmer and drier since 1950, they said, but similar trends were observed before the atomic age.

A study of the weather records for the past 10 years does not indicate any unusual weather which appears to be related to the position of the atomic clouds or the times of explosions, they stated. No evidence has been found which would indicate that atomic explosions have produced any change in climate.

Scientists, they said, have examined the most plausible proposed theories about effects of atomic explosions on weather. Among these (and the findings of investigations into them) are:

1 Rainfall. The debris from an atomic explosion might serve as a cloud-seeding agent and increase the rainfall under the atomic cloud.

Laboratory tests of the dust thrown into the air by atomic explosions in Nevada indicate that it is not effective as a cloud-seeding agent, the Weather Bureau scientists reported. Observations of the ice nuclei concentration (cloud-seeding material) in the atmosphere indicate that this does not increase when the radioactivity due to atomic explosion increases.

2 Temperature. In theory the debris from an atomic explosion should reflect some of the sun's rays back to space and decrease the temperature at the ground.

Actually, according to Dr. Machta and Mr. Harris, no decrease in strength of the sun's ray is observed on days when atomic clouds are overhead. Moreover, the amount of material thrown into the atmosphere by an atomic explosion is so small, when compared to that resulting from a dust storm or a forest fire, that no detectable effect should be expected.

3 Radioactivity. The presence of natural radioactivity in the atmosphere and cosmic rays should make the atmosphere a conductor of electricity.

The increased radioactivity of the atmosphere caused by an atomic explosion, they said, will lead to a small but noticeable increase in its conductivity for a few days after each blast. Under extreme conditions, this increase in conductivity might decrease the amount of lightning in a thunderstorm.

Private Nuclear-Research Reactor

Plans for the building of the first nuclear reactor to be owned and operated by private industry for research in industrial and humanitarian fields have been completed by American Machine & Foundry Company, New York, N. Y.

A number of leading industrial concerns have been invited to participate in the program on a co-operative basis. Meetings to implement the program are now in progress. In addition to building the reactor, AMF will be one of the participants in the program.

Each company will be represented on a Board of Directors which will establish policy for the operation of the reactor facility. Participating companies will be from the electronics, petroleum, food, pharmaceutical, chemical, ceramics, rubber, metals, textile, agricultural, machinery, and other industries.

The first reactor and its supporting laboratory facilities will cost between $1,000,000 and $1,500,000 and can be constructed and available for use within 18 months. It is planned that the facility will be built in the New York area on a site of approximately 250 acres.

Research reactors are essentially producers of radiation—neutrons, gamma and beta radiations, and other radiations which are emitted from the inner structure of the atom. Through the effective use of these radiations on commercial products and processes the reactor becomes an important tool in industrial research and development.

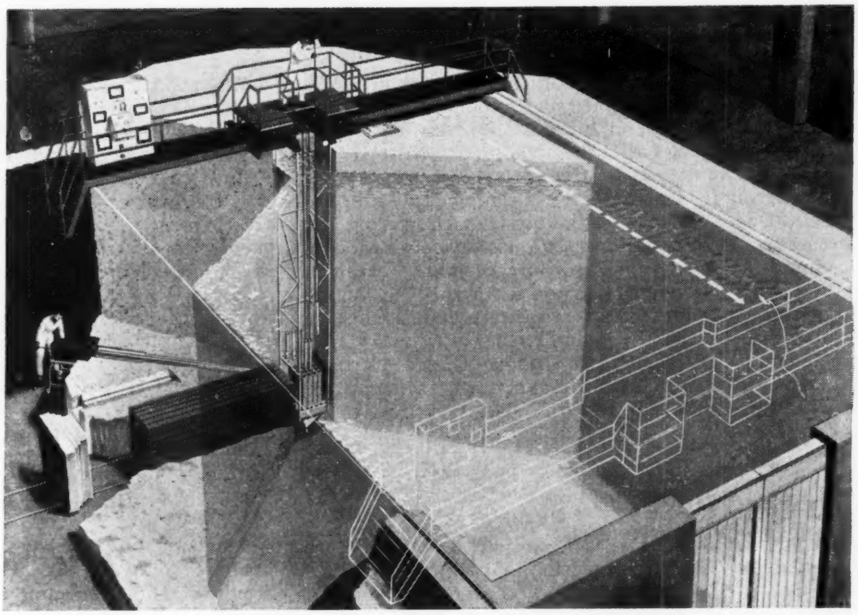


Fig. 9 The first nuclear-research reactor to be owned and operated by private industrial concerns, as seen in an artist's "cutaway" conception. This swimming-pool-type reactor employs American Machine & Foundry Company's unitized design to provide flexibility for undertaking a wide variety of research and development work.

Solid-Fuel-Type Reactor

The reactor proposed for the Industrial Research Facility will be of a design already proved by operating experience and will have the anticipated flexibility required to conduct a wide variety of work. It will be a solid-fuel type employing a core similar to that in the Materials Testing Reactor at the National Reactor Testing Station in Idaho. This type of research system is the only one which has operated successfully at the high flux levels required for industrial development work.

Specifications are as follows: Type, heterogeneous, swimming-pool type; fuel, uranium-iron alloy clad with stainless steel formed into plate-type elements; moderator, light water; reflector, light water and graphite; shield, light water and concrete; coolant, light water; controls, boron carbide rods; power, 100 to 1000 kw; flux, up to 1×10^{13} n/cm^2/sec.

The design concept of the AMF-built reactor would be one of "utilization." This concept permits the standardization of certain components resulting in ease of construction and prevents early obsolescence.

The Industrial Reactor Research Facility will make possible research investigations in materials, sterilization and pasteurization of foods, radiation, chemistry, biochemistry and biology, radioisotope production, medicine, physics, and reactor technology. The outstanding advantage of nuclear reactors as a research device is their capacity to handle relatively large volumes of experimental work, their ease of operation, and overall flexibility.

Battelle Reactor

It was also announced that AMF was awarded a contract for the design, engineering, and construction of a nuclear-research reactor by Battelle Institute, Columbus, Ohio.

The reactor will be a key component in a $1,500,000 atomic-research center Battelle is building 15 miles west of downtown Columbus.

The reactor will be designed to be of broad use in the study of problems of industry. It will be of the "swimming-pool" type and modeled somewhat after the Bulk Shielding Reactor at the Oak Ridge National Laboratory. Its primary function will be to provide an intense source of neutrons and atomic radiation for research uses. In this respect it will supplement a large cobalt 60-gamma radiation source now being installed by Battelle, and reactor development and hot-cell laboratories planned by the Institute, in providing private industry with complete facilities for studies in the field of atomic energy.

The reactor, together with auxiliary equipment and the building in which it is to be housed, will cost about $500,000. Construction will begin after review and licensing by the Atomic Energy Commission. The target date for "going critical" is Feb. 1, 1955.

AEC-ASME Development Project

The Atomic Energy Commission and The American Society of Mechanical Engineers will share the cost of a $25,000 engineering project to develop information in the field of high-temperature piping, the AEC announced recently. The investigations will be performed by the AEC's Knolls Atomic Power Laboratory, Schenectady, N. Y., which is operated by the General Electric Company. The ASME, on behalf of American industry, will contribute $10,000, and a group of ASME technical experts will be available at no cost to the government for consultations in the programming and evaluation of the work.

The project will continue studies of thermal fatigue in ductile metals which were originally undertaken by the AEC to provide information for the reactor development program. General engineering information applicable to heat-transfer systems will be developed which will be of future benefit to the AEC program.

Private industry has an immediate need for this type

of information, and ASME has undertaken to sponsor the work for this reason. The testing facilities to be used and the resulting information are unclassified. The program will not interfere with other AEC work at KAPL.

The work to be performed under contract between the ASME and the General Electric Company will be directed by Dr. L. F. Coffin, Jr.

The joint venture is another instance of private enterprise sharing in the cost of the development work of the AEC. Under the AEC's industrial-participation program various organizations or groups of organizations are paying costs of engineering and economic feasibility studies of the technology of power reactors and their byproducts. In another venture the Duquesne Light Company of Pittsburgh, Pa., and North American Aviation, Inc., of Downey, Calif., are sharing the cost of the development, construction, and experimental operation of two power reactors in the AEC's five-year reactor program.

Dry Fluid Drive

A DRY fluid drive, called Flexidyne, developed for use in industrial-power transmission, has been announced by the Dodge Manufacturing Corporation of Mishawaka, Ind.

The drive is based upon a new principle and, it is said, can easily handle difficult starting and reversing problems. It also gives a new kind of protection against shock and overloads. Its major advantages over any other fluid-type drive are based on the fact that at normal operating speeds it does not slip. At the same time, in the case of an overload, it is slippage which gives protection.

Thousands of installations have already been made in Europe where the drive was originated. It has been redesigned by Dodge to American standards and will be available from stock through regular Dodge distributors.

It is claimed to have wide application for industrial drives involving heavy inertia and shock loads on such equipment as compressors, centrifuges, conveyers, crushers, and machines used in metalworking plants, textile mills, and the oil fields.

The Flexidyne drive is made up of a housing, inside of which a rotor is free to turn concentrically. Between the two are fine particles of spherical steel shot, called the "flow charge," which acts much like a fluid. It is the flow charge which transmits power from the housing to the rotor. This flow charge is easy to seal in, has a high density, and can withstand relatively high temperatures.

Briefly the Flexidyne drive works as follows:

1 The motor is connected to the housing and starts it turning at no load.

2 The flow charge is thrown to the circumference of the housing, is compressed by centrifugal force, and revolves with the housing.

3 The rotor, connected to the load, is started and accelerated by the friction and wedging action of the revolving flow charge.

4 Rotor and housing reach identical speeds—the Flexidyne operates with zero slippage between motor and load at normal running speeds.

5 In case of overload, before damage is caused, the Flexidyne rotor slips relative to the housing, overcoming the friction and wedging action of the flow charge. A thermal switch which automatically cuts the electrical circuit if an overload

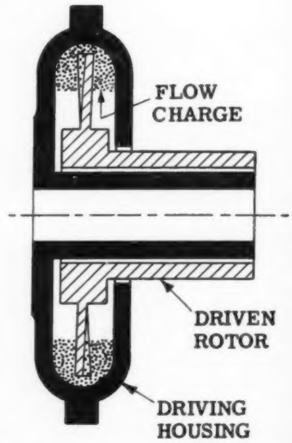


Fig. 11 Line cross section of dry fluid drive

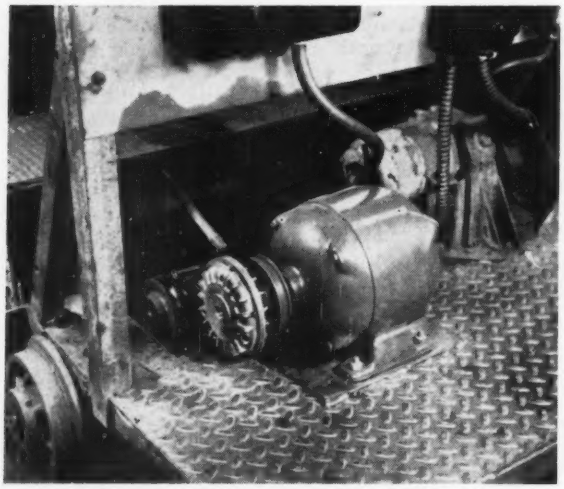
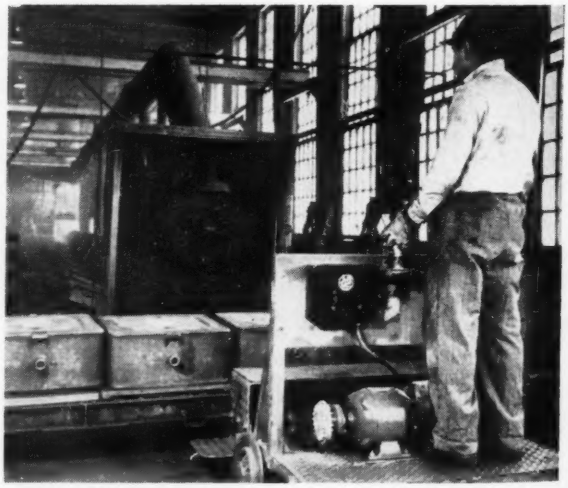


Fig. 10 Approximately two tons of iron and sand are carried by this foundry cart equipped with Flexidyne, the new dry fluid drive. The Flexidyne picks up power from a $^3/_4$-hp squirrel-cage motor (1150 rpm, 440 volt, 60 cycle, 3 phase). The power is delivered through a Taper-Lock V-belt drive and a



Torque-Arm speed reducer mounted on the drive-axle shaft. The cart, push-button controlled, takes off with its full load as smoothly as a modern elevator. It travels at 160 fpm, comes to rest smoothly, and can be reversed or inched like an elevator to an exact location.

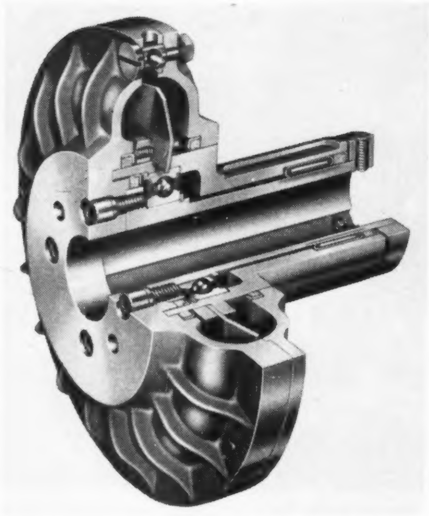


Fig. 12 Cutaway view of the dry fluid drive

persists is available as optional equipment from Dodge.

The amount of the flow charge determines the torque capacity. Because it is easy to vary the amount of this charge, the Flexidyne will give the exact starting torque needed for anything from the smoothest to the fastest start.

Accurate overload protection is assured as the Flexidyne can be set to slip at anywhere from as low as a gentle 20 per cent over full-load torque to as high as peak-motor torque. During starting and overload periods the current drawn is at a minimum because, with the standard Flexidyne setting, the motor is never pulled down to less than 90 per cent of synchronous speed.

All this is due to Flexidyne's principle, which produces constant torque for a given input speed, regardless of the percentage of slip between the rotor and the housing (which occurs only during starting or overload).

Further advantages of the Flexidyne drive, according to the Company, are as follows:

1 With Flexidyne uniform performance is assured regardless of changes in the surrounding temperatures. The Flexidyne has very long life and requires practically negligible maintenance. Its simplicity is the basis of its dependability.

2 Aside from Flexidyne's low first cost, low maintenance, and top efficiency, it permits the use of smaller cheaper motors and controls, with greatly reduced current demands and improved power factor. Its smoother starts and gentler overload protection avoid breakage and reduce maintenance on drives, gears, bearings, and driven machinery.

3 Flexidyne is simple to select off the shelf. Each size has a standard horsepower rating and yet it is only a matter of minutes to vary the flow charge to give the exact torque required to suit a particular job.

Two lines will be available: (1) Flexidyne drives for convenient mounting directly on motor shafts and adapted for Dodge Taper-Lock sheaves, and (2) Flexidyne couplings, with Taper-Lock bushings for straight-line drives. First to be offered from stock will be four sizes of Flexidyne drives, rated at 3 to 30 hp at 1800 rpm. Other sizes will follow.

Mobilvan Freight System

A SYSTEM for transporting freight that combines the most economical aspects of trucking and railroad transportation was introduced recently by Clark Equipment Company of Battle Creek, Mich.

Called the Clark Mobilvan System, it not only can move freight, but stores it as well—thereby providing a mobile warehouse. This flexible shipping method is adaptable to use with either truck or rail transportation, where circumstances dictate the use of one type of carrier exclusively, as well as in combined movements utilizing both.

The system uses lightweight vans 17 ft long, 8 ft wide, and 8 ft high, designed with automatic locking devices that enable them to be fastened securely to the bed of a railroad flatcar or the body of a flat-bed highway truck.

An expenditure of approximately $500 per unit would be required to adapt existing railroad flatcars with the automatic locking devices. The expenditure necessary to adapt existing flat-bed trucks would be less. This modification would not restrict the use of present rolling

Fig. 13 For long cross-country hauls, the 17-ft-long Mobilvans may be transported by rail, three to a standard flatcar. At the destination they are unloaded by either a 30,000-lb capacity fork-lift, shown here, or a straddle carrier specially adapted for the service.

Fig. 14 At the end of its rail journey the Mobilvan is removed from the railroad flatcar and placed on a flat-bed truck for delivery to its final destination. The 17-ft Mobilvan is equipped with channels into which forks of the lift truck can easily slide.

equipment to the Mobilvan System and would therefore cut down on initial capital investment.

Three Mobilvans Fit on a Flatcar

The 17-ft length permits the loading of three Mobilvans on a standard railroad flatcar, which is 53 ft 6 in. long. Two Mobilvans can be transported on a conventional 35-ft highway trailer, and one on a city delivery flat-bed truck.

Merchandise is loaded into the Mobilvan at the shipper's loading dock. During loading, the Mobilvan can be either on a flat-bed truck trailer or, if the shipper has a fork-lift truck, it can be at ground or floor level. Movements of the Mobilvan between a loading dock and flatcar or a trailer can also be accomplished by using a large straddle carrier.

Once loaded, the Mobilvan is hauled to the railroad freight terminal, removed from the highway truck by a fork-lift truck or a straddle carrier, and placed aboard a railroad flatcar. Or the container could be carried by truck to a trucking terminal to be combined with another Mobilvan on a highway trailer for a long overland haul. At the end of its rail journey the Mobilvan is removed from the flatcar by fork-lift truck or straddle carrier and placed on a flat-bed truck for delivery to its final destination.

To effect final delivery of the merchandise, the Mobilvan can be left atop the flat-bed trailer. The volume of merchandise shipped would determine whether it would be economically feasible to invest in a fork-lift truck or straddle carrier large enough to handle a loaded Mobilvan.

An important advantage of the Mobilvan is that, following delivery, the container can become a convenient storage structure for contents that are not immediately needed. By contrast, it is economically unfeasible to immobilize a conventional highway trailer for storage purposes.

Cost Estimated at Less Than $1500

The steel Mobilvan is designed for a capacity of 20,000 lb of freight. When empty, it weighs 3000 lb. Cost of a Mobilvan is estimated at less than $1500.

The Mobilvan is designed for handling by two items of materials-handling equipment manufactured by Clark. One is the 30,000-lb capacity Clark-Ross fork-lift truck. The other is a Ross straddle carrier adapted for this purpose. Cost of the fork-lift truck is approximately $17,500 and the straddle carrier $25,000.

Atomic Clock

A UNIQUE "atomic clock" has been perfected at Columbia University, New York, N. Y. Harnessing directly the tiny quanta of energy given off by molecules of ammonia gas, the device can measure time with greater accuracy than has been possible before. For the first time it exceeds, by a considerable margin, the currently accepted standard of the earth's rate of rotation.

The "maser" (short for "Microwave Amplification by Stimulated Emission of Radiation") can also be operated as an amplifier of radio signals in the microwave frequency range. It utilizes a new principle, which for the first time permits amplification of high-frequency radio waves without the use of electronic vacuum tubes.

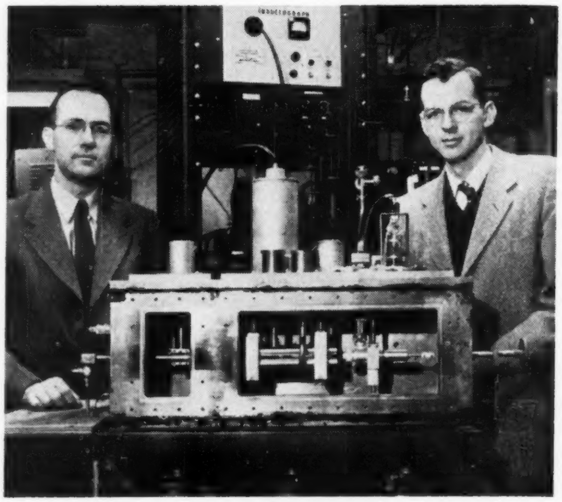


Fig. 15 Shown here is a new kind of timing device, an atomic clock, that uses directly the energy radiated by molecules of ammonia gas. Called the maser, it was invented by Prof. Charles H. Townes (*left*) in the Columbia Radiation Laboratory. Dr. J. P. Gordon (*right*) aided in the development. Now the most accurate clock in existence, the maser doubles as a supersensitive amplifier of microwave radio signals.

When functioning as an atomic clock, the maser produces oscillations of 24 billion cycles per second—directly from the radiation of ammonia molecules. Frequency variation over short periods of time, on the order of a few seconds, is a very small fraction of one cycle per second. Over longer periods it does not drift more than several cycles per second.

Many times more sensitive than a vacuum tube, the maser is a virtually noise-free amplifier. This noise-free characteristic makes it possible for the device to amplify successfully radio signals that would be too weak for conventional vacuum-tube amplifiers to handle.

Noise level with the maser is practically at the theoretical minimum of zero decibels. At high microwave frequencies, the best vacuum-tube amplifier is unable to keep the noise level lower than about plus 15 decibels.

The maser will have immediate applications in radio communications, microwave transmission and reception, and navigation. Scientists also will find it useful for accurately measuring time, for determining the earth's rate of rotation, and for examining the structure of molecules and atomic particles with greater precision.

Briefly, the maser works like this: A stream of ammonia gas is forced under slight pressure into one end of a sealed chamber. As the ammonia molecules enter the chamber, from which all the air has been removed by vacuum pump, they float into the control of an electrostatic field. This field "focuses" the beam of molecules into two parts. One part consists of molecules in low-energy states (which customarily absorb energy), and the other contains molecules in high-energy states (which radiate energy). The low-energy molecules are diverted from the beam, while the high-energy ones are directed into a "cavity"—a small copper cylinder open at one end.

The cavity is the heart of the maser. Within its

walls, which are specially designed to form a resonant enclosure, some of the ammonia molecules undergo "transitions," giving up tiny amounts of energy in the process. These tiny quanta of energy, in turn, trigger other ammonia molecules, causing them to radiate their energy as well. And so, by a kind of molecular chain reaction, a relatively large amount of energy quickly builds up inside the cavity.

If there are sufficient molecules to start a self-sustaining chain reaction, then oscillation occurs inside the cavity and microwaves are continuously emitted from it. If fewer molecules are present, the maser acts like an amplifier (in which case an external signal is introduced).

The operator can decide on the kind of operation he wants, therefore, by simply adjusting the flow of ammonia into the chamber, and hence controlling the number of molecules that will be available to the cavity. The rate of flow of ammonia gas during oscillation is approximately 10^{15} molecules per second (one quadrillion).

Besides the adjustment for type of operation, there is one for frequency. The cavity can be "tuned" to slightly different resonant frequencies, thus affecting the output frequency of the microwaves; but the maximum change possible by this adjustment is only one part in ten million. For large changes in output frequency, molecules of substances other than ammonia would be used in the maser, since each kind of molecule has its own distinctive resonant frequency. Common table salt, NaCl, is one of the other compounds that will be tried.

The microwave output from the cavity, at most a mere 10^{-8} watts (ten billionths of a watt), flows out through a waveguide and is piped to its destination much like a liquid or gas would be. The waveguide is a small-diameter hollow-metal pipe connected to the cavity and carried up through an airtight opening in the top of the evacuated chamber.

Two complete masers have been built so far and both are now operating in the Columbia Radiation Laboratory. The first occupies a rectangular brass box roughly one foot square in cross section and three feet long. The other, a somewhat later model, has about the same cross section but is considerably shorter. It was necessary to build two of the devices so that one could check the other—as the most accurate measuring instrument of its kind, it can't be adequately tested any other way.

Electric-Energy Production

Production of energy by electric utilities in the United States during 1954 reached a new high of 471,609,103,000 kwhr, 6.5 per cent above the previous record set in 1953, according to preliminary figures released by the Federal Power Commission in its "Production of Electric Energy in the United States" series.

Hydro plants generated 107,130,521,000 kwhr during 1954, for 22.7 per cent of the total amount. The hydro production was up 1.8 per cent from the 105,233,348,000 kwhr produced during 1953. Utility thermal production was up 8 per cent over 1953.

Combined utility and industrial production in 1954 was 5.9 per cent above the previous year, reaching a record 544,645,484,000 kwhr. Industrial production alone was 73,036,381,000 kwhr, also a record, and 2.1 per cent above the 1953 output.

Utility capacity at the end of 1954 was 102,520,056 kw, which reflects a gross increase of 11,682,508 kw and a net gain of 11,017,807 kw, or 12 per cent during the year, and a net increase of 1,414,039 during December. Utility and industrial capacity totaled 118,885,250 kw at the end of the year and industrial capacity alone was 16,365,195 kw.

For the month of December, production by electric utilities totaled a record 43,426,747,000 kwhr, an increase of 5.5 per cent over the previous high of 41,166,600,000 kwhr produced in August, 1954. December production was 11.1 per cent above the 39,083,232,000 kwhr produced during December, 1953.

Water-power plants produced 9,048,009,000 kwhr in December, an increase of 4.3 per cent over the monthly production of 1953. As a per cent of December total production, water-power output decreased from 22.2 per cent in 1953 to 20.8 per cent in 1954.

Industrial production, including generation by railway and railroad plants, was 6,460,471,000 kwhr in December, an increase of 7.1 per cent over the same month in 1953.

Combined utility and industrial production was 49,887,218,000 kwhr during December, 10.6 per cent above the same month in 1953.

The report is compiled from data filed with the FPC by electric utilities and industrial plants of the United States, and may be obtained from the Federal Power Commission, Washington 25, D. C., for 10 cents.

Liquid Semiconductor

A liquid has been found that behaves electrically like a solid semiconductor.

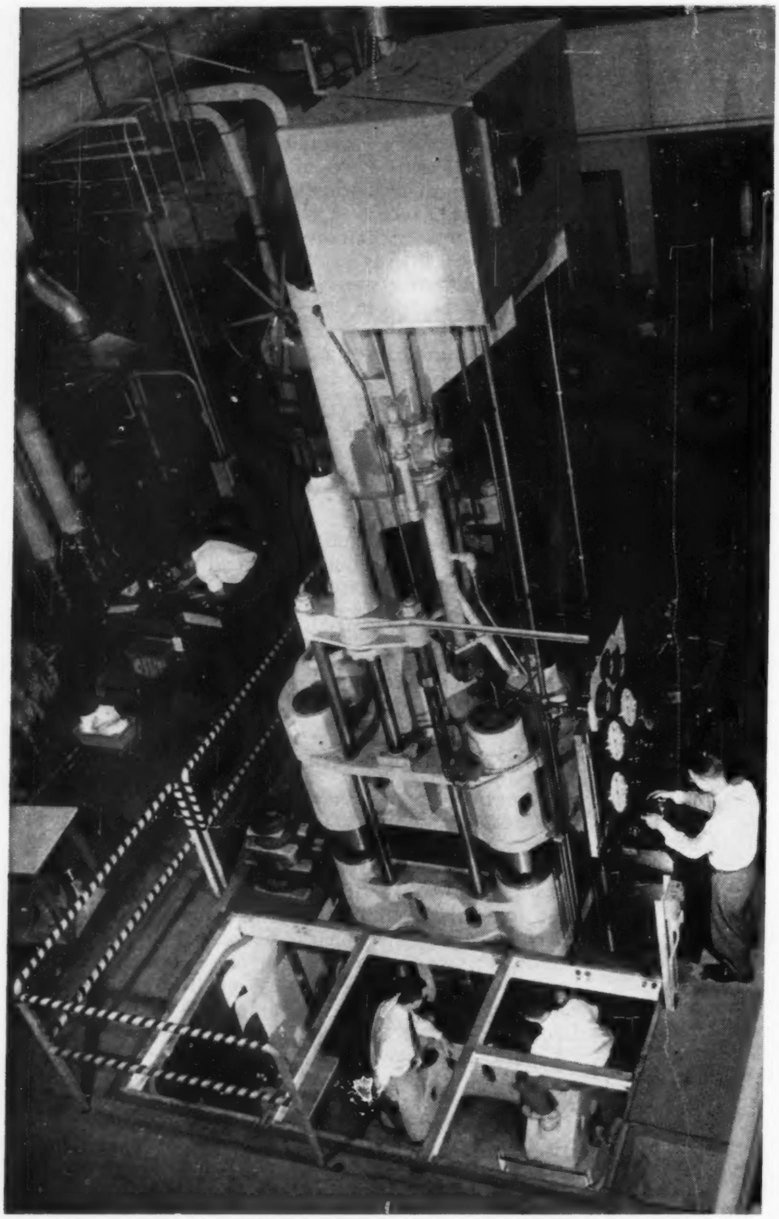
The best-known example of semiconduction in a solid is the transistor. Made of solids like germanium or silicon, the transistor conducts electronically, rather than ionically as in a battery, and the amount of conductance increases with temperature.

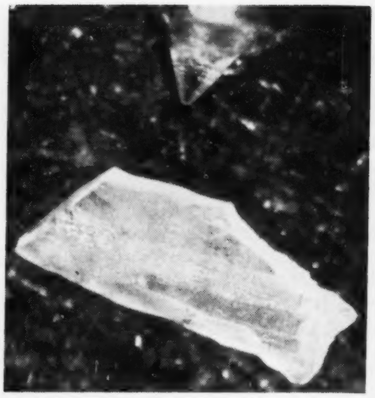
Now this same phenomenon of semiconduction has been found in liquids—molten metallic sulphides—at Carnegie Institute of Technology Metals Research Laboratory, Pittsburgh, Pa. The discovery was made by Drs. G. M. Pound and Gerhard Derge as they worked on an Atomic Energy Commission project dealing with electrochemical studies of nonaqueous melts.

In the case of ordinary salts such as sodium chloride, either molten or in a water solution, electric current is carried by ions as in a battery. Exploring less familiar liquids such as those used in metallurgical processes, it was found that the molten-liquid sulphides, unlike aqueous solutions or molten ionic salts, behave like a semiconductor. Instead of conducting electricity by the transport of charged atoms (ionically), it conducted electricity by the flow of electrons as in an ordinary wire. But unlike ordinary metals, the conductance increased with temperature.

Existing theories on the nature of semiconduction cannot account for the new discovery since they apply exclusively to solids such as the transistor and not to liquids where the atoms are in a state of disorder.

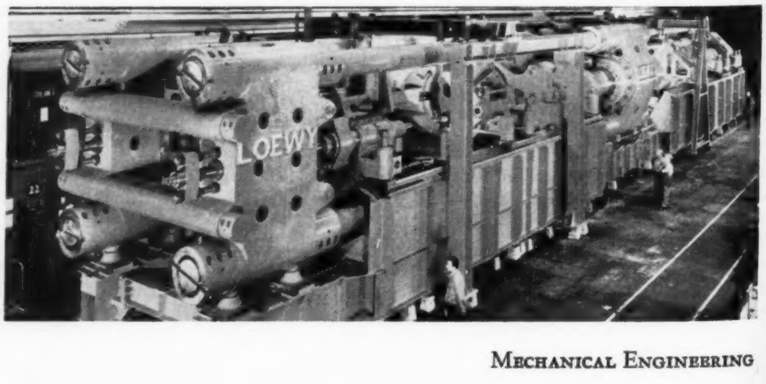
In a joint statement, the Carnegie Tech metallurgists said, "Much of the information that can be obtained from customary solutions at room temperature is already known. Our discovery may provide a new tool for probing the persistent mysteries of liquid structure."





Man-Made Diamonds. Scientists of the General Electric Research Laboratory recently exhibited tiny diamonds made from a carbonaceous material subjected to extreme pressures and temperatures. The largest stone measured $^1/_{16}$ in. in longest dimension. Under hardness tests, the G-E diamonds proved capable of scratching anything—even other diamonds. The scientists responsible for the project were Drs. Francis P. Bundy, H. Tracy Hall, Herbert M. Strong, and Robert Wentorf. In Dr. Strong's process, a carbonaceous compound was subjected for many hours to a measured pressure some 53,500 times greater than atmospheric (roughly 800,000 psi). That run, in the laboratory's new 1000-ton press, yielded a crystal nearly $^1/_{16}$ in. long. Of fundamental importance was the work of Dr. Hall, who extended Dr. Bundy's initial high-pressure work and developed the "belt," a chamber enabling G-E scientists to maintain for the first time temperatures above 5000 F at pressures in excess of 1,500,000 psi. Using this equipment, Dr. Hall developed a process that produces diamonds in a matter of minutes. Hall's diamonds are smaller, but are often produced in solid clusters. Single runs have produced up to $^1/_{10}$ of a carat. Dr. Wentorf likewise had success with the same physical apparatus employed by Hall, though different chemical conditions were present. At left is G-E's 1000-ton press for achieving high pressures (100,000 atm or 1.6 million psi). Shown above is the largest diamond yet made by G-E. About $^1/_{16}$ in. long, it has been photographed beside a standard diamond, high-fidelity phonograph needle to indicate its relative size.

8000-Ton Extrusion Press. This 8000-ton hydraulic extrusion press designed and engineered by Loewy-Hydropress, Inc., and built by Nordberg Manufacturing Company, is one of two Loewy presses to be installed at the Kaiser Aluminum & Chemical Corporation, Halethorpe, Md., plant, as part of the U. S. Air Force Heavy Press Program. A third Loewy extrusion press of similar design will be installed at Harvey Machine Company, Torrance, Calif. This press is almost 174 ft long with hydraulic equipment, controlling mechanism, and run-out tables. It weighs about 4,000,000 lb.

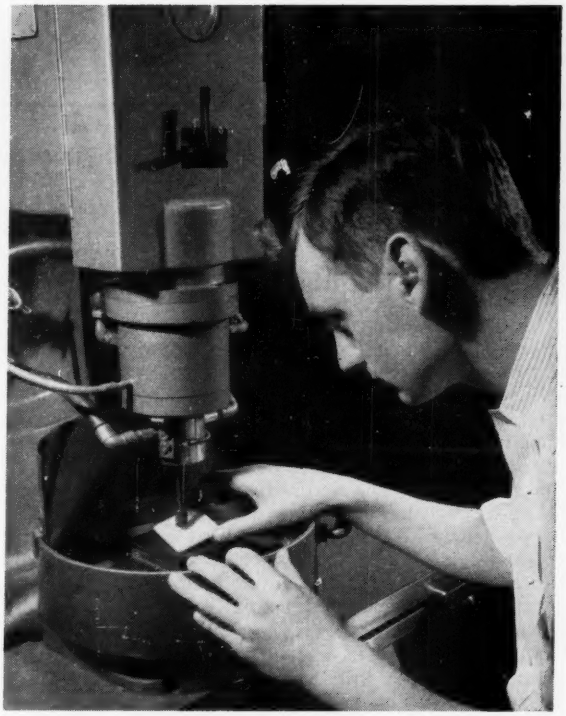


Echoscope. Large hub is examined ultrasonically with the Curtiss-Wright Echoscope. Locations where flaws in metal, if any, occur are shown on screen of Echoscope. Device operates on impulse-echo system, with a single unit serving as transducer and receiver. This system solves the problem of inspecting large parts which cannot be moved easily, irregularly shaped pieces, and material where only one side is accessible. Curtiss-Wright Corporation of Wood-Ridge, N. J., recently displayed the Echoscope along with a series of new products at the company's Science and Industry Show in New York, N. Y.

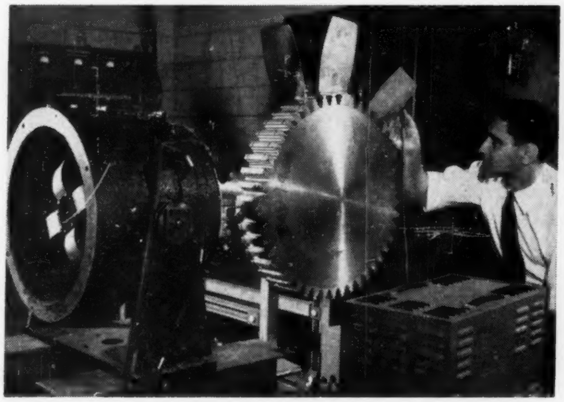
Engineering Developments

. . . at a glance

High-Strength Wire Rope. One of the primary markets for American Chain & Cable Company's new high-strength wire rope will be the petroleum field. The added strength of rotary drilling lines, in the same diameter, gives additional weight-lifting capacity for deeper drilling. An average tensile strength of 300,000 psi was achieved by use of special precise analysis high-carbon steel wire and improved processing.



Ultrasonic Drill. Intricate shapes may be cut into metals, ceramics, glass, carbides, and other hard materials with the Curtiss-Wright Diatron, an ultrasonic drill that bores without rotating. The drills may be fashioned easily and inexpensively from soft metal into any desired geometric form. In operation, the head moves imperceptibly up and down thousands of times a second to drive an abrasive solution into the workpiece. No finishing or polishing is required after the drilling. The unit was also shown at Curtiss-Wright Corporation's recent Science and Industry Show in New York, N. Y.



Steam Power. Completion of Westinghouse Electric Corporation's $32 million expansion program at its Steam Division, South Philadelphia, Pa., has more than doubled the division's productive capacity for steam turbines and associated equipment. In addition, a new $6 million steam and gas-turbine research and development laboratory has been completed. Shown here is a laboratory technician holding vibration-measuring probe to blades while vibration exciter induces vibration in spindle. The setup is mounted on seismic mass to isolate external vibration.

European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] *European Correspondent*

60-Ton Electric Tilting Furnace

Most heavy electrical plant involves a good deal of mechanical engineering in its construction and often in its operation also, which is the justification for recording in "European Survey" the setting to work near Sheffield, England, of a 60-ton-capacity electric-arc tilting furnace for steelmaking, Figs. 1 and 2. It is the largest of its kind in the British Isles and at present the largest in Europe. However, a similar furnace of twice the capacity is under construction for a steelworks in Belgium. It is a good example of the technical co-operation that exists in many branches of engineering between the United States and Britain, having been made by the firm of Birlec, Limited, of Birmingham, England, under license from the Pittsburgh Lectromelt Furnace Corporation.

Installed in the Stocksbridge Works of Samuel Fox and Company, Limited, one of the constituent firms in United Steel Companies, Limited, it is being used to produce alloy steels and has an output of over 1000 tons a week. The shell of the furnace is 19 ft diam, with a refractory lining 18 in. thick on the side walls and 27 in. thick on the bottom. It tilts through 45 deg forward for pouring and 15 deg backward for slagging. The furnace is supported on cast-steel toothed segments, rolling on toothed racks, carried on reinforced-concrete foundation walls.

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

The roof, lined with 14 in. of silica brick, is raised and swung over to the pouring side, together with three 20-in-diam electrodes, to allow the furnace to be charged. This is done with a bottom-discharging bucket, big enough to hold a full charge of 60 tons of scrap and provided with four bracket feet which rest on the rim of the furnace shell. When the bucket is in this position, the clamshell bottom doors (operated by chains from the overhead traveling crane) are only a short distance above the bottom of the furnace, so that the charge has not far to drop and damage to the refractory lining is consequently minimized. The operations of raising and swinging the roof and of tilting the furnace are carried out by oil-hydraulic rams under remote push-button control, the pressure oil being supplied by three pumps, driven by 30-hp motors.

The electrodes are raised and lowered through the roof of the furnace by electric winches, but are secured by clamps which are pneumatically opened against spring pressure. The clamps are copper castings and are water-cooled, as also are the slagging and side doors, with their jambs and arches, and the hollow box-section ring, which forms the rim of the furnace on which the roof rests. The current for melting is taken from the public supply through a 15,000-kva transformer. A diesel-driven-runabout charging machine, mounted on rubber-tired wheels, is used for adding alloying materials, etc., to the charge in the furnace.

The furnace, with its associated equipment, is contained in a new melting shop, standing on a level piece of ground, about 100,000 sq ft in area, which had to be

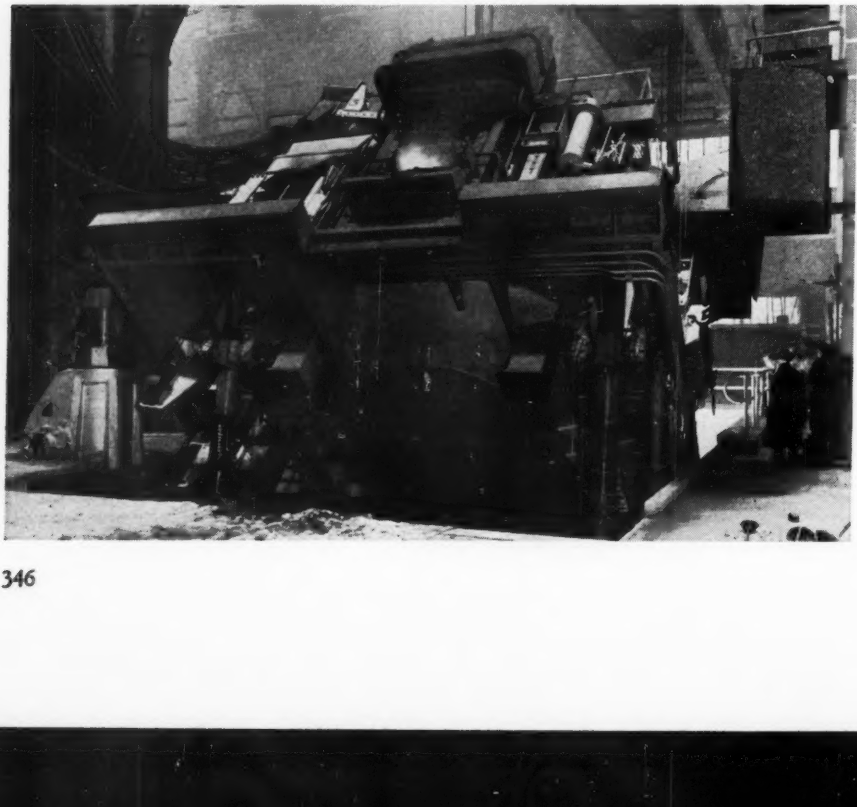


Fig. 1 60-ton Birlec Lectromelt furnace tilted at the completion of its pour exposing the stainless-steel bottom

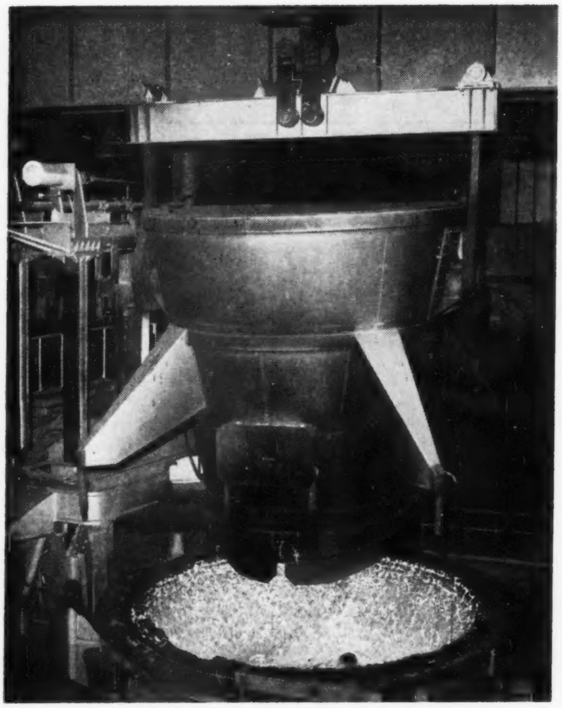


Fig. 2 Charging 60-ton Lectromelt furnace from the specially designed clam-type charging bucket. The bucket arms rest on the shell rim before bucket is opened to release charge.

scooped out of a hillside, the valley in which the works stands being very narrow at that point. This required the excavation and removal of about 750,000 tons of earth and rock.

Dynamic Balancing Machine

A DYNAMIC balancing machine, designed primarily for balancing the rotors of jet engines, but suitable also for use with pump impellers, fans, etc., which do not require to be constructed with such extreme accuracy, has been put into production by L. M. Ericssons Mätinstrument AB, of Stockholm, Sweden. It is called the YRB 30 type, and is illustrated in Fig. 3.

The feature of particular note is that the torque is transmitted directly from the driving motor through a belt of plastic material, as close as possible to the center of gravity of the rotor or other component under test. To measure vibrations in a horizontal direction, the driving belt must be vertical. A belt-tightening device is introduced, therefore, by means of which a vertical drive can be obtained. The rotor to be tested is suspended in two resilient bearings which can perform substantially undamped oscillations in the horizontal plane. Each bearing is connected to a vibration indicator consisting of a coil inserted in the airgap of a permanent magnet. Lack of balance in the rotor, causing the bearings to vibrate, sets up sine-wave alternating voltages in the indicators, proportional to the vibrations. Two synchronous generators, one for each balancing plane, are mounted on the stand containing the measuring equipment, and produce reference voltages, the phase positions of which can be varied by turning a handwheel.

The vibration voltage and the reference voltage are fed to the two coils of the indicating instrument, which shows a deflection that is dependent on the product of the two voltages and the cosine of the phase angle between them. By this means the angular position of the unbalance can be ascertained. It is read directly from a scale on the handwheel which turns the stator of the reference generator. It is also possible to locate the position optically by means of two lamps, one for each balancing plane, which light up when the point causing the unbalance in the plane concerned is facing vertically upward.

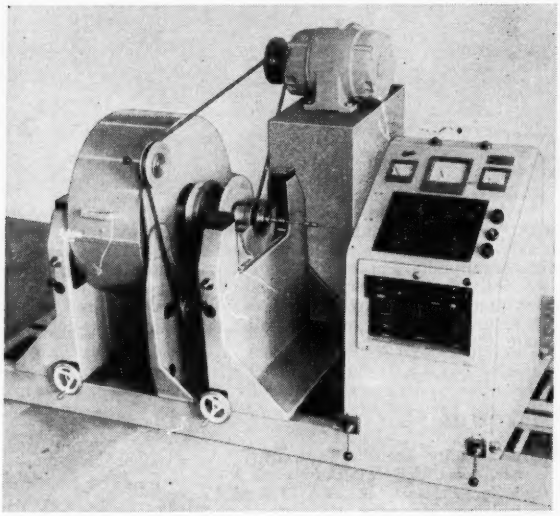


Fig. 3 Dynamic balancing machine for jet-engine rotors

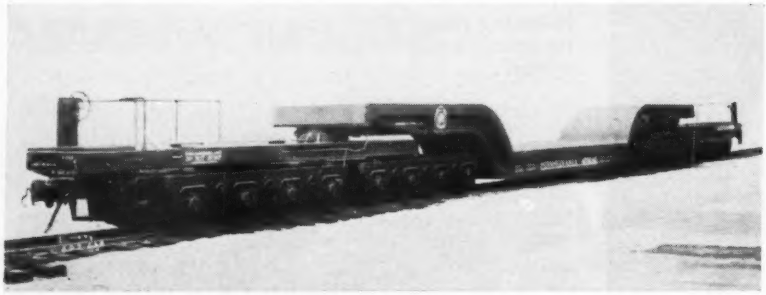
The machine can test rotors from 6 lb to 2000 lb in weight and up to 40 in. in diam. The maximum distance between the bearings is normally 80 in., but this can be increased if necessary; and the balancing speed is from 490 to 900 rpm. Vibrations with amplitudes as small as 0.00001 in. can be measured.

British Industries Fair

THIS year's British Industries Fair, which will be held from May 2 to May 13 at Castle Bromwich, near Birmingham, and at the group of halls known as Olympia, in London, is the first to be organized entirely by private enterprise, as was recommended in the Goodale Report of 1953. Previously, the Fair was a semigovernment activity in which the Board of Trade co-operated with the Birmingham Chamber of Commerce. Now the Board of Trade is officially out of it, its place being taken by a company under the name of British Industries Fair, Limited; though, in view of the importance of the Fair to British export trade, the Government has promised financial support. As in former years, machinery will be exhibited at Castle Bromwich; and, on the basis of advanced information from the manufacturers, the level of technical interest promises to be well sustained.

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings



Pennsylvania Railroad Company's Class FD-2, 500,000-lb-capacity depressed-center flat car with weldment body built at the Altoona Works. Eight-wheel $6^1/_2$-in. x 12-in. axle roller-bearing trucks were taken from large-capacity tenders which were being scrapped. These trucks were connected with a span bolster forming dual 8-wheel trucks for supporting each end of the car body. The wheels are 36 in. diam and with a total of 32 wheels per car, the load-per-inch of wheel diameter is 873 lb with axles loaded to capacity. With this truck arrangement, the FD-2 car can negotiate a 250-ft radius curve.

Railroads

Heavy-Capacity Freight Cars, by J. A. Gower, Mem. ASME, Pennsylvania Railroad Co., Philadelphia, Pa. 1954 ASME Annual Meeting paper No. **54—A-173** (multilithographed; available to Oct. 1, 1955).

This paper on high-capacity freight cars deals with the mechanical details of heavy-duty-type depressed-center, well, and special flat cars, both American and European types. Similar data are included for ore cars, gondola cars, and house or boxcars. A detailed description is given of the shop procedure used in building the body weldment of the 32-wheel, 500,000-lb-capacity Pennsylvania Railroad Company's depressed-center flatcar.

Possibilities of Burning Lower-Cost Diesel Fuels, by Ray McBrian, Mem. ASME, Denver and Rio Grande Western Railroad Company, Denver, Colo. 1954 ASME Annual Meeting paper No. **54—A-250** (multilithographed; to be published in Trans. ASME; available to October 1, 1955).

The question of getting the most out of diesel fuel and the possibilities of burning lower-cost diesel fuels involves more than the operational price savings. It requires a knowledge and understanding of the facts of combustion as related to engine performance and the effects of the characteristics of fuels and means by which undesirable features can be recognized and corrections made so that fuels may be burned satisfactorily in service.

The Denver and Rio Grande Western Railroad has, through research and an understanding of fuel characteristics, been using for over a year on the entire fleet of diesel locomotives lower-cost fuels, which have reflected material savings without any appreciable increase in maintenance costs. However, the control of diesel locomotives with the use of the spectrograph and the proper changing of oil and air filters and the proper study of diesel fuels has been necessary to secure such savings without increasing maintenance costs.

Fuels which the Denver and Rio Grande Western Railroad are using are not the regular type of specified burner oils, but are fuels which have been selected by the railroad and refiner from unstable stocks or from study of refinery streams, whereby the refiners have been able to reduce also operational refining costs and share such savings with the railroad.

Actual service performance tied in with the research studies have proved that such type fuels, by which price savings can be obtained, can be successfully used. The actual savings for each of the fuels selected for use range from $^3/_4$ cents to $4^1/_4$ cents per gal. No specifications have been placed upon the refiner except those of water and dirt content.

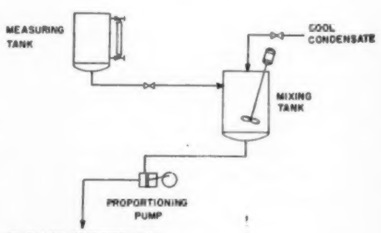
Boiler Feedwater Studies

Hydrazine for Boiler-Feedwater Treatment, by R. C. Harshman, Olin Mathieson Chemical Corporation, Niagara Falls, N. Y., and E. R. Woodward, Olin Mathieson Chemical Corporation, Baltimore, Md. 1954 ASME Annual Meeting paper No. **54—A-124** (multilithographed; available to Oct. 1, 1955).

Physical and chemical properties of hydrazine are discussed, particularly as they relate to its use for scavenging dissolved oxygen in boiler feedwater. Amount of hydrazine to use, methods of application, and methods of control of dosage are described.

Use of hydrazine in central power stations has confirmed the fact that it can reduce corrosion caused by dissolved oxygen without undesirable effects on boiler operation. Maintenance of a hydrazine residual in the water protects the boiler against occasional increases in dissolved oxygen content which occur with variations in operating conditions. Hydrazine does not interfere with the normal control of pH of the boiler water, and it does not contribute to the total solids content of the water. It has been found to be easy to apply, and satisfactory methods have been developed for control of the dosage required.

A start has been made in the use of



A simple method of application of hydrazine to boiler feedwater is shown, using a small chemical proportioning pump to inject dilute hydrazine hydrate into the feedwater line against back pressure

hydrazine in industrial-plant boilers in the United States, and early results indicate advantages which, upon further confirmation, will increase its use in this field.

Controlling Iron and Copper Pickup With Neutralizing Amines, by J. D. Ristroph, Virginia Electric and Power Company, Richmond, Va., and E. A. Yorkgitis, Hall Laboratories, Inc., Pittsburgh, Pa. 1954 ASME Annual Meeting paper No. **54—A-262** (multilithographed; available to Oct. 1, 1955).

CYCLOHEXYLAMINE and morpholine were fed to minimize pickup of iron and copper by controlling pH in the steam-feedwater cycle of a high-pressure, reheat, controlled-circulation boiler.

With either morpholine or cyclohexylamine fed to maintain a condensate pH of 9.0-9.1, Fe and Cu concentrations in No. 3 Unit of Chesterfield Station are kept at very low values—less than 0.01 ppm throughout the steam-condensate-feedwater cycle. Attainment of these desirably low levels may be due in part to rigid control over other factors influencing the pickup of metals in the steam-feedwater cycle. Oxygen contamination is probably the most important of these other factors.

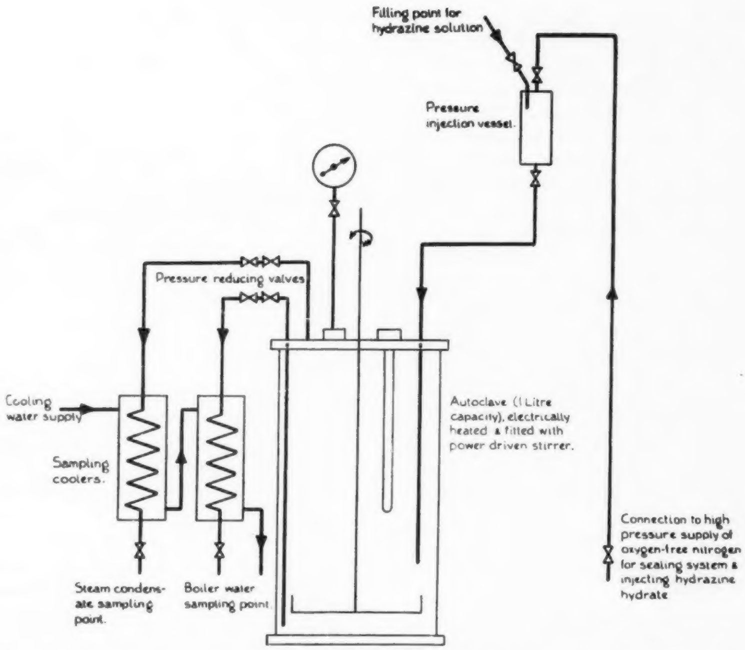
Good sampling facilities and analytical procedures are essential in obtaining reliable data. Of particular importance are the continuous flow of samples, solubilization of Fe and Cu in the sample, and the use of sensitive indicators such as batho-phenanthroline and neo-cuproine in the determinations of these metallic contaminants.

Feed requirements for maintenance of pH are approximately the same in the cycle under study with either morpholine or cyclohexylamine. Build-up of ammonia in the system because of breakdown of either amine is negligible. However, part of the small amount of ammonia discarded with the after-condenser drains represents possible breakdown of the amines.

The Chemical Deaeration of Boiler Water—The Use of Hydrazine Compounds, by J. Leicester, Admiralty Materials Laboratory, Dorset, England. 1954 ASME Annual Meeting paper No. **54—A-123** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

PRELIMINARY stages in an experimental study of the reaction rates of the hydrazine-oxygen system are described.

Work is continuing along four main lines: A bench-scale study of the mechanism of and the factors influencing the reaction, an investigation of reaction rates in a static autoclave system, study of reaction rates in a pilot-plant high-pressure boiler, and a series of full-scale boiler trials.



Details of experimental autoclave unit used at British Launderers' Research Association. At the beginning of an experiment the stirrer in the autoclave is started and the hydrazine in the injection vessel is shot into the autoclave. Samples of water and steam are taken after approximately 2 min. and subsequently every 10 min. over a total period of about 1 hr. Water samples are then analyzed for unreacted hydrazine and the steam-condensate samples for unreacted hydrazine and ammonia.

The simple reaction between hydrazine and oxygen has been shown to be far more complex than was at first thought to be the case and perhaps the most important conclusion is that even in dilute solutions, this can proceed as a surface reaction. The experiments serve to indicate that in the present state of knowledge, it would not appear possible to predict the efficiency of the reaction for a universal boiler application and that to achieve the desired result, some form of reaction catalyst may have to be developed.

Hydrazine as an Oxygen Scavenger—A Progress Report on Tests at Springdale Station, by M. D. Baker, West Penn Power Company, Springdale, Pa., and V. M. March, Hall Laboratories, Inc., Pittsburgh, Pa. 1954 ASME Annual Meeting paper No. **54—A-261** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

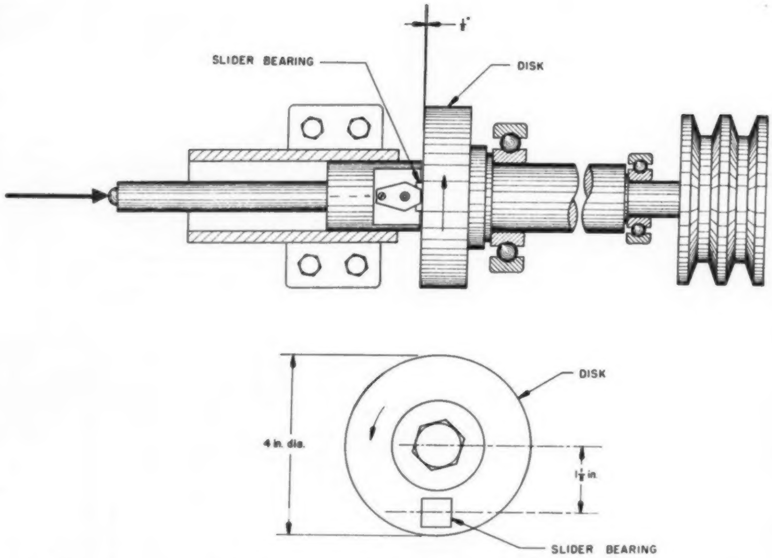
HYDRAZINE has been fed on a trial basis to a 1350-psi boiler at Springdale Station of West Penn Power Company since April, 1954. Preliminary observations on the use of this chemical for removing oxygen are given.

Hydrazine reacts only slowly with dissolved oxygen at ordinary temperatures. Hydrazine in saturated steam at 345 F also reacts slowly with oxygen. In a boiler at 1350 psi, excess hydrazine decomposes so rapidly that it is not possible to maintain more than a few hundredths of a part per million in the boiler water. When hydrazine decomposes in a boiler at 1350 psi, one end-product is ammonia. Indications are that decomposition is substantial in a superheater with maximum temperature of 930 F. The rate of decomposition in a boiler at 115 psi is relatively low since it is possible to maintain a reserve of at least several parts per million of hydrazine in the boiler water. At 115 psi, the steam carries from 5 to 10 per cent as much hydrazine as is present in the boiler water; volatilization is greater at 1350 psi.

When hydrazine is used as an oxygen scavenger, the pH of the condensate will be increased, since ammonia resulting from its decomposition will be carried

with the steam. The increase in pH from the hydrazine volatilized with the steam in the case of the 1350-psi boiler is small compared to the increase from ammonia produced by decomposition. Pickup of iron and copper by condensate at a pH not exceeding 9.2 was kept to no more than 0.015 ppm of Fe and 0.003 ppm of Cu while hydrazine was fed to a 1350-psi boiler.

Compared on the basis of cost of removing a unit of oxygen, hydrazine is currently several times as expensive as sodium sulphite and about as expensive as potassium sulphite. The basic problem in the use of hydrazine in a high-pressure plant is to proportion the hydrazine to the oxygen in the feedwater so that the latter will be removed without appreciable waste of hydrazine by decomposition of any excess reaching the boiler.



Schematic diagram of slider-bearing test machine. Various metallic elements were tested in the form of slider bearings, measuring $^5/_8 \times {}^5/_8$ in., pressed at an angle of $^1/_2$ deg against the face of a 1045 steel disk. Disk speed was 5400 rpm, giving an average sliding velocity of 4640 fpm. The load was applied by means of weights which acted through a beam. The load was variable between zero and 1200 lb.

Lubrication

Load Capacity and Time Relations for Squeeze Films by F. R. Archibald, Mem. ASME, Arthur D. Little, Inc., Cambridge, Mass. 1954 ASME Annual Meeting paper No. **54—A-50** (multilithographed; available to Oct. 1, 1955).

The transient load capacity of a fluid film between two surfaces having a relative normal velocity is often of importance and the term squeeze film applied to such a situation is at once accurate and descriptive. Although the subject is far from new in the literature of lubrication it does not seem to have been treated very fully by any one author.

The purpose of this paper is to show how the transient load capacity and the time-to-change thickness of various film configurations can be calculated and to catalog a number of results of practical interest some of which do not seem to have been given previously. An analogy to certain other important physical problems is mentioned.

Scoring Characteristics of Thirty-Eight Different Elemental Metals on High-Speed Sliding Contact With Steel, by A. E. Roach, C. L. Goodzeit, Assoc. Mem. ASME, and R. P. Hunnicutt, General Motors Corporation, Detroit, Mich. 1954 ASME Annual Meeting paper No. **54—A-61** (multilithographed; available to Oct. 1, 1955).

This paper takes up the "score resistance" of elemental substances, chiefly metals, in high-speed sliding contact with steel. Score resistance is the ability of materials to slide against each other without welding or otherwise sticking together. The terms "galling," "seizing," and "metal transfer and pickup" are sometimes used as synonyms for scoring.

Score resistance is a property of great practical importance in bearings, piston rings, shaft seals, gears, and all parts that rub together. Although it is a property that has been studied for many years, very little is actually known about it.

A study has been made of the score resistance of 38 elemental metals tested as slider bearings against 1045 steel disks. It was found that the metals that have the best score resistance against steel are the B-subgroup metals which are either insoluble with iron or else form intermetallic compounds with iron.

Preliminary Investigation of Minimum Oil-Feed Rate for Fluid-Film Conditions in Journal Bearings, by D. D. Fuller, Mem. ASME, Columbia University, New York, N. Y., and Beno Sternlicht, General Electric Company, Schenectady, N. Y. 1954 ASME Annual Meeting paper No. **54—A-107** (multilithographed; available to Oct. 1, 1955).

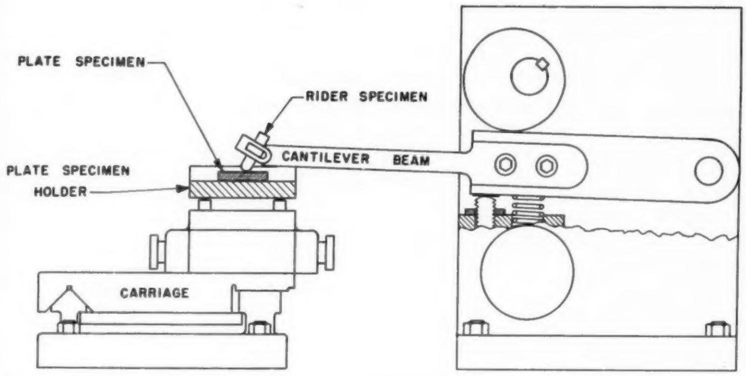
Many industrial bearings do not operate with an abundant supply of lubricant. Bearings that are fed with wicks, pads, and drop-feed oilers, for example, are found in this category. It has been demonstrated that a certain volume of lubricant must be supplied to a journal bearing to permit the formation of a complete hydrodynamic fluid film. Since it is generally desirable to have bearings operate with a fluid film in order to develop the least friction and wear, the question of determining the minimum rate of feed in order to insure such operation is of some importance.

The work described in this paper has resulted in a method which appears promising for predicting the minimum feed rate for a journal bearing. The minimum feed rate is evaluated in terms of speed, load, clearance, and size of bearing. The method is based on a theoretical analysis supplemented by experimentally determined constants.

Frictional Characteristics and Surface Damage of Thirty-Nine Different Elemental Metals in Sliding Contact With Iron, by C. L. Goodzeit, Assoc. Mem. ASME, A. E. Roach, and R. P. Hunnicutt, General Motors Corporation, Detroit, Mich. 1954 ASME Annual Meeting paper No. **54—A-53** (multilithographed; available to Oct. 1, 1955).

This paper describes an experimental investigation of the friction and surface-damage characteristics of iron in sliding contact with various elemental metals without lubrication.

No simple, direct relationship was found between the value of the coefficient of sliding friction and the characteristics of the material transfer between metals. It was found that the surface-damage



Schematic diagram of friction test machine. This apparatus is a convenient means of holding, loading, and providing relative motion between two test specimens. One specimen is a flat plate; the other, called the rider, is a cylinder with a hemispherical end. The plate specimen is mounted on a carriage which moves at a uniform slow velocity along horizontal ways. The rider is attached to a cantilever beam in such a way that its hemispherical end contacts the plate specimen.

characteristics are related to the relative hardness of the metals in sliding contact, their mutual solubility, and their ability to form intermetallic compounds.

Bearing Material Evaluation for Railroad Use, by G. M. Robinson, Assoc. Mem. ASME, The Franklin Institute Laboratories for Research and Development, Philadelphia, Pa. 1954 ASME Annual Meeting paper No. **54—A-110** (multilithographed; available to Oct. 1, 1955).

This paper describes in detail a machine built in connection with a study for the Association of American Railroads to assist in the evaluation of bearing materials for railroad freight-car journal bearings.

Typical coefficient of friction versus time and bearing temperatures versus time curves are discussed for both phases of the evaluation program: (*a*) When the material is being run-in under a copious supply of oil, and (*b*) when the bearing is running with an inadequate supply.

Curves of five different materials are presented and different performance characteristics are discussed. The possibility of using this machine to evaluate the performance of special lubricants is pointed out.

The Friction Process in Metal Cutting, by Iain Finnie, Shell Development Company, Emeryville, Calif., and M. C. Shaw, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Annual Meeting paper No. **54—A-108** (multilithographed; available to Oct. 1, 1955).

Coefficients of friction obtained in metal cutting are often greatly different from those obtained with the same metal pair in conventional sliding-friction experiments. If only the rake angle is changed during cutting, a wide range of friction coefficients is obtained, and it is noted that the tendency toward complete adhesion of chip to tool increases as coefficient of friction decreases. These two apparent anomalies are explained by considering the fundamental mechanism of friction and the conditions which exist in cutting. It is shown that a coefficient of friction is inadequate to characterize the friction process in cutting, being mainly an indication of the normal stress on the tool face, and thus strongly dependent on the shear process in cutting.

Boiler and Pressure Vessels

The Design of Vertical Pressure Vessels Subjected to Applied Forces, by E. O. Bergman, Mem. ASME, C. F. Braun & Company, Alhambra, Calif. 1954 ASME Annual Meeting paper No. **54—A-104** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

Pressure-Vessel codes do not give design methods except for the relatively simple case of cylindrical shells with standard-type heads and openings under uniform pressure. The designer must apply engineering principles when he deals with more complicated structures and loading systems.

This paper discusses some design principles that are not covered in the codes.

The paper discusses some problems of design of cylindrical pressure vessels that have their axis vertical and are subjected to applied forces in addition to internal or external pressure. The vertical forces considered are the weight of the vessel and its contents and the weight of any attachments to the vessel. The horizontal forces include wind pressures, seismic forces, and piping thrusts.

Stresses From Radial Loads in Cylindrical Pressure Vessels, by P. P. Bijlaard, Cornell University, Ithaca, N. Y. 1954 ASME Annual Meeting paper No. **54—A-101** (multilithographed; available to Oct. 1, 1955).

Local forces transmitted to cylindrical pressure vessels through various attachments, nozzles, lugs, clips, and the like, often result in local stresses which cannot be neglected in design.

This paper contains design information on deflections, bending moments, and membrane forces caused in cylindrical vessels by radial loads uniformly distributed over a rectangular area $2c_1 \times 2c_2$. The cylindrical shell wall is assumed to be simply supported at the ends, which means that there the radial deflections, the bending moments, and the tangential displacements are zero. The derivation of the equations from which this information was computed will be published separately.

The data in this paper allow the direct determination of maximum stresses and deflections for design purposes. Comparison with the scattered, available test results reveals good agreement with the computed values.

The content of this paper represents part of the results of a research project on Effects of External Loads on Pressure Vessels sponsored at Cornell University by the Pressure Vessel Research Committee of the Welding Research Council.

Procedure Used for Selecting Stress Values for the ASME Unfired Pressure-Vessel Code, by M. B. Higgins, Mem. ASME, Stamford, Conn. 1954 ASME Annual Meeting paper No. **54—A-164** (multilithographed; available to Oct. 1, 1955).

The ASME Boiler and Pressure Vessel Code, Section VIII, covering Unfired Pressure Vessels, contains rules for the design and construction of pressure-containing equipment. For use in the design of such equipment this Section of the Code has tables of maximum allowable stress values in tension. These tables list the stress values for temperatures up to the maximum metal temperatures permitted by the Code rules.

The Subcommittee on Stress Allowances for Ferrous Materials of the ASME Boiler and Pressure Vessel Committee has the responsibility of establishing stress values for all of the ferrous mate-

rials approved for Code construction. This Subcommittee also recommends the maximum metal temperatures at which the materials may be used.

This paper reviews the source of data, the basis for establishing stress values, the procedure used for selecting stress values, and decisions of the ASME Subcommittee on Stress Allowances for Ferrous Materials in setting of maximum stress values in tension for ferrous materials in the ASME Code for Unfired Pressure Vessels.

Fluid Meters

Flow of Saturated Boiler Water Through Knife-Edge Orifices in Series, by E. S. Monroe, Jr., Mem. ASME, Cornell University, Ithaca, N. Y. 1954 ASME Annual Meeting paper No. **54—A-118** (multilithographed; available to Oct. 1, 1955).

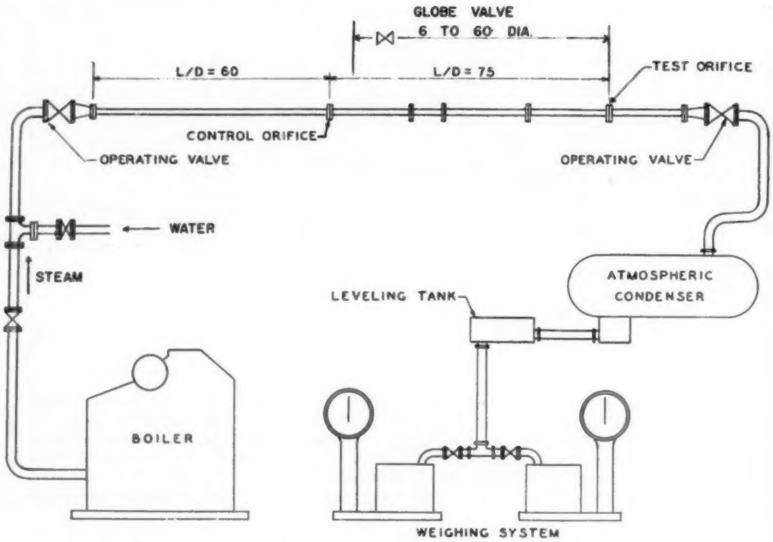
Whenever water, or other liquid, flows from some pressure to a lower pressure and the initial temperature is greater than the saturation temperature corresponding to the final pressure, flashing of the liquid into vapor can occur. As a result, flow formulas for cold water are erroneous when applied to the flow of heated and compressed liquids.

This paper presents the results of experiments with the flow of saturated boiler water through from one to four knife-edge orifices arranged in series. A useful equation is developed to conform to both the available published data and the author's experimental results when the back pressure on the orifice is at or near barometric conditions.

Effect of a Globe Valve in Approach Piping on Orifice Meter Accuracy, by J. W. Murdock, Mem. ASME, C. J. Faltz, Assoc. Mem. ASME, and C. Gregory, Jr. U. S. Naval Boiler & Turbine Laboratory, Philadelphia Naval Base, Philadelphia, Pa. 1954 ASME Annual Meeting paper No. **54—A-122** (multilithographed; available to Oct. 1, 1955).

A major requirement for the metering of fluid flow by means of an orifice is that the flow approaches the orifice in a normally turbulent pattern, a condition which can be obtained by providing adequate length of straight pipe preceding it. The Joint AGA-ASME Committee on Orifice Meters has established standards of piping requirements delineating this length of pipe for the most common types of installations. These standards, however, provide only for the condition of no interference and little information is available showing the magnitude of change in the indicated flow rate when less than the minimum straight pipe is used. Since space is often limited, and particularly so aboard ship, this problem of less than the minimum required straight pipe and the magnitude of error in flow measurement therefrom, is a recurring one.

This paper presents the results of a series of steam and water tests on sharp-edged thin-plate orifices preceded by a globe valve at various distances. Curves are given, showing the magnitude of change in indicated flow, when the approach piping is less than that recommended by the Joint AGA-ASME Committee on Orifice Meters. Comparative curves with the valve throttled are also given.



Flow diagram of apparatus used in steam and water tests on sharp-edged thin-plate orifices preceded by a globe valve. The test section consisted of a straight run of 4-in. pipe, 147 pipe diameters long, discharging into a condenser, thence to a weighing system. Either steam or water could be introduced into the system. Two orifice assemblies were used, designated "control" and "test" for the up and downstream locations, respectively.

Notes on Some Recently Published Experiments on Orifice Meters, by Edgar Buckingham, deceased, formerly with The National Bureau of Standards; presented by Howard S. Bean, Fellow ASME, National Bureau of Standards, Washington, D. C. 1954 ASME Annual Meeting paper No. **54—A-244** (multilithographed; available to Oct. 1, 1955).

A procedure for plotting orifice coefficient data which results in straight lines over a considerable range of conditions is presented. By relating the slopes and intercepts of these lines to size ratio and the Reynolds number parameters, it is possible to represent the coefficients for a wide range of sizes and rates by two linear equations.

By applying this procedure to several available sets of data the limits of applicability of the equations are determined. Furthermore, it is shown that the mechanical finish of the orifice plate surface and orifice edge affect both the slope and intercept of the lines resulting from the initial plottings.

Discharge Measurements at Low Reynolds Numbers, Special Devices, by A. L. Jorissen, Mem. ASME, Cornell University, Ithaca, N. Y. 1954 ASME Annual Meeting paper No. **54—A-190** (multilithographed; available to Oct. 1, 1955).

The utilization of constant-area differential types of fluid meters is in many cases limited to conditions for which the coefficient of discharge may be considered as practically independent of Reynolds number. This is true for orifices, nozzles, and venturi tubes. Under a certain value of Reynolds number, the coefficient of discharge exhibits a variable trend. The discharge may then be computed only by a method of successive approximations. Furthermore, experimental evidence shows that the accuracy of the device is generally lowered.

Since the accurate measurement of discharge at low Reynolds numbers is important in many cases (oils, various solutions, gases containing a large amount of hydrogen, hot gases, gases as low pressure), the twofold problem hat

arisen of investigating the behavior of standard devices at low Reynolds numbers and of studying new types of devices, more suitable for the measurement of fluid flow to Reynolds numbers as low as possible. To this end, numerous investigations have attempted to develop new types of differential fluid meters in which, by compensation of the effects of contraction and friction, a constant value of the coefficient of discharge can be maintained at low Reynolds numbers.

It is concluded that a number of devices offer distinct possibilities of maintaining a constant coefficient of discharge down to low values of Reynolds number. Noteworthy are the quarter-round orifice and the cylindrical nozzle with or without conical diffuser. For both, experimental evidence is available as proof of their satisfactory operation.

Effect of Mechanical Vibration on the Water Flow Through a $^1/_4$-In. Sharp-Edged Concentric ASME Orifice in a 1-In. Pipe, by C. B. Haughton, Jr., Mem. ASME, Avco Manufacturing Corporation, Stratford, Conn., and R. E. Gorton, United Aircraft Corporation, East Hartford, Conn. 1954 ASME Annual Meeting paper No. **54—A-113** (multilithographed; available to Oct. 1, 1955).

In the fall of 1952, during the development of a new-type flowmeter containing both variable-area and constant-area orifices, the Fischer and Porter Company discovered that mechanical vibration was seriously affecting the performance of the constant-area orifice.

Results of special vibration tests on this orifice led into the investigation presented in this paper in which it was found that a severe vibration of 4*g* produced a flow error of 55 per cent at an orifice differential pressure of 0.95 in. of water.

Shortly after these tests were completed, Pratt & Whitney became interested in the phenomena and set up a considerably improved test in which it was able to produce nearly pure transverse and axial vibrations of the flowing orifice and pipe. These tests demonstrated that axial vibrations produce far greater flow errors than transverse vibrations, and typical maximum error of 83 per cent lower flow with a vibration of 5*g* at 150 cycles per second (cps) was measured. The Pratt & Whitney tests not only appear to confirm the Fischer and Porter tests but also show that the effects of *g* and frequency are considerable.

A physical interpretation of what happens at the orifices is offered for consideration, and recommendations for future investigation are presented. The results reported should be of particular interest to users of extremely small orifices.

Two and Three-Dimensional Flow of Air Through Square-Edged Sonic Orifices, by A. Weir, Jr., J. Louis York, Mem. ASME, and R. B. Morrison. University of Michigan, Ann Arbor, Mich. 1954 ASME Annual Meeting paper No. **54—A-112** (multilithographed; available to Oct. 1, 1955).

In this investigation the two-dimensional flow of air through rectangular and the three-dimensional axisymmetrical flow of air through circular, square-edged sonic orifices was examined under pressure ratios ranging from 1.894 to 42.0 (upstream stagnation pressure/downstream static pressure). Mass flow measurements were made using a primary metering system, rather than another orifice or nozzle, and optical techniques were used to obtain pictures of the flow upstream, within the thickness of the orifice plate and downstream of the orifice.

Evidence is presented which indicates that square-edged sonic orifices can be treated as sonic nozzles by utilizing the concept that the air "turning the corner" of the orifice plate, in effect makes its own nozzle. It is believed that this interpretation of experimental observations is in full agreement with established principles of aero and thermodynamics.

On the Theory of Discharge Coefficients for Rounded-Entrance Flowmeters and Venturis, by M. A. Rivas, Jr., Assoc. Mem. ASME, and A. H. Shapiro, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1954 ASME Annual Meeting paper No. **54—A-98** (multilithographed; available to Oct. 1, 1955).

A theory of rounded-entrance flowmeters, based on a consideration of the potential and boundary-layer flows in a converging nozzle, is constructed.

Curves are presented showing the discharge coefficient as a function of diameter Reynolds number, with the "total equivalent length-diameter ratio" of the nozzle as a parameter. An investigation of the frictional equivalent length-diameter ratio of the contraction section of the ASME long-radius nozzle shows this ratio to decrease from a value of about 0.56 at a diameter Reynolds number of 1,000,000 to a value of about 0.25 at a diameter Reynolds number of about 1000. In the range of diameter Reynolds numbers from about 1 to 1000, the equivalent length-diameter ratio is approximately 0.2.

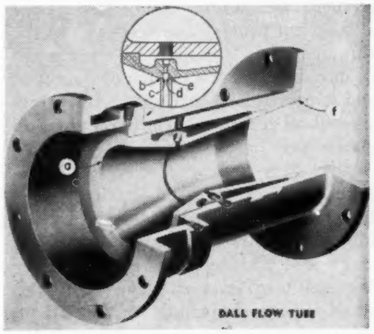
The theoretical curves of discharge coefficient versus Reynolds number are in good agreement with experiment.

The Dall Flow Tube, by I. O. Miner, Mem. ASME, Builders-Providence, Inc., Providence, R. I. 1954 ASME Annual Meeting paper No. **54—A-139** (multilithographed; available to Oct. 1, 1955).

The Dall Flow Tube is a primary flow-metering device that has been in use in England for some time. Examination of the Dall flow tube gives the impression that a fluid flowing through it would be subject to a very high head loss. Actually, the loss is lower than for any other known primary device which operates by developing pressures dependent on the acceleration of the fluid.

Limitations are encountered in the measuring of flow of fluids containing solids which might settle out in the throat slot, and more straight pipe is required than for some other standard flow-measuring devices. Also, the coefficient becomes variable below a Reynolds number considerably higher than that at which a venturi coefficient starts to vary.

Data were provided on coefficients and effects of upstream disturbances for the benefit of researches and users of Dall flow tubes.



A cross section through a typical Dall flow tube. The flow first strikes a dam at "a." After the flow passes through the inlet cone it encounters a sharp edge at "b" and at "c." The flow next traverses the open throat slot, after which it strikes two more sharp edges, "d" and "e." At point "f" the flow undergoes sudden enlargement to the pipe diameter. The whole device is approximately 2 diameters long.

Metal Processing

Residual Grinding Stresses in Hardened Steel, by H. R. Letner, Mellon Institute of Industrial Research, Pittsburgh, Pa. 1954 ASME Annual Meeting paper No. **54—A-56** (multilithographed; available to Oct. 1, 1955).

Residual stresses resulting from surface grinding a hardened ball-bearing-type steel under closely controlled conditions were measured by the deflection method, and the effects of wheel grade, unit downfeed, and grinding fluid upon the stresses generated were studied. The stress gradients close to the surface were found to be quite steep and, in a number of instances, both components of the biaxial stress were compressive at the surface. This behavior contrasts with previous dry-grinding experiments on annealed steel and indicates the possibility of generating compressive surface stresses in hardened steel by grinding.

It was concluded that grinding stresses in a ball-bearing steel, quenched and tempered to Rockwell hardness C59, do not exhibit the high tensile values found close to the surface in an annealed tool steel of comparable carbon content, ground under similar conditions. They also do not penetrate as deeply as in the annealed steel. Compressive stresses can be developed in the surface of quenched and tempered ball-bearing steel by abrasive-wheel grinding. The effect of wheel grade upon residual grinding stresses is small. Very soft wheels appear to reduce the magnitude and depth of penetration somewhat. In general, increasing the unit downfeed increases both the magnitude and depth of penetration of the resulting stresses. The change is small for unit downfeeds up to 0.001 in. when grinding with a soft wheel. Other conditions being the same, use of different grinding fluids can result in large differences in the residual-stress distributions.

The Determination of Residual Stresses in Hardened, Ground Steel, by L. V. Colwell, Mem. ASME, M. J. Sinnott, and J. C. Tobin, University of Michigan, Ann Arbor, Mich. 1954 ASME Annual Meeting paper No. **54—A-52** (multilithographed; available to Oct. 1, 1955).

Residual surface stresses induced by grinding a hardened SAE 4340 steel have been investigated by means of x-ray diffraction and by optical interferometric methods. The depth of penetration of the residual stresses increases as the severity of grinding is increased. The higher the hardness level of the steel, the greater is the absolute value of the residual stress. The magnitude of the residual stresses varies from 100,000 psi in tension to 135,000 psi in compression depending on the hardness level of the steel and the severity of grinding. Light grinding produces residual compressive stresses while heavy grinding produces tensile stresses.

The Effect of Wheel-Work Conformity in Precision Grinding, by R. S. Hahn, Mem. ASME, The Heald Machine Company, Worcester, Mass. 1954 ASME Annual Meeting paper No. **54—A-178** (multilithographed; available to Oct. 1, 1955).

Conformity between wheel and work is defined in terms of the trochoidal work surface at the region of engagement. Experimental results are presented for a variety of wheels which show that the rate of metal removal varies as the 0.18 power of the curvature difference. Two modes of grinding action are recognized, one in which stock removal is proportional to work speed and independent of wheel speed, and the other where the reverse is true. A mechanism of grinding action is proposed and a theoretical formula relating rate of stock removal to normal force and curvature difference is derived which in certain respects agrees remarkably well with experiment.

Cutter Design and Application for Face-Milling Cast Iron and Steel, by O. W. Boston, Fellow ASME, University of Michigan, Ann Arbor, Mich., and W. W. Gilbert, Mem. ASME, General Electric Company, Schenectady, N. Y. 1954 ASME Annual Meeting paper No. **54—A-51** (multilithographed; available to Oct. 1, 1955).

This is the third paper giving results of tests to face-mill a variety of metals with cutters of various materials, sizes, and shapes. The work was sponsored by the War Production Board under the auspices of the Office of Production Research and Development, through the Manufacturing Engineering Committee of The American Society of Mechanical Engineers. The work was done on a project with the Engineering Research Institute of the University by the staff and in the laboratories of the department of production engineering at the University of Michigan.

This paper gives results on cutter design and application for both carbide and high-speed steel face-milling cutters when machining steel and cast iron. Variables, for each material, consisted of axial rake angle, radial rake angle, tooth profile, peripheral relief angle, peripheral cutting-edge angle, nose radius, width of chamfer, number of teeth in the cutter, cutter diameter, blunting of the cutting edges, cutting speed, and cutting fluids. For each of the variables, net power and unit net power at the cutter, together with the cutting speed for a 30-min tool life, are given and recommendations are made for the most appropriate cutter design.

Plastic Working of Metals, by W. S. Wagner, E. W. Bliss Company, Canton, Ohio. 1954 ASME Annual Meeting paper No. **54—A-64** (multilithographed; available to Oct. 1, 1955).

Material presented in this paper is in itself a brief review of the art of plastic working of metals which was compiled to stimulate discussion at the first annual meeting following the establishing of the ASME Research Subcommittee on the Plastic Working of Metals.

The thermoplastic and crystoplastic states are presented as two distinct ranges of plastic working dependent on temperature. Basic laws governing these phenomena must be delineated. Work-hardening and deformation strength are pointed out with one method of estimating deformation strength from true strain. The effect of aging after plastic working is introduced. The relationship between per cent reduction of area and true strain as measures of the extent of plastic working is presented.

Further study of these fields and introduction of new problems along with definition of terms and development of both theory and practice are the responsibilities of the committee.

Stresses and Strains in Cold-Extruding 2S-O Aluminum, by E. G. Thomsen, Mem. ASME, and Joseph Frisch, Assoc. Mem. ASME, University of California, Berkeley, Calif. 1954 ASME Annual Meeting paper No. **54—A-161** (multilithographed; available to Oct. 1, 1955).

2S-O aluminum was extruded at room temperature in an inverted extrusion process from a 4.3-in-diam cylindrical billet into a 1.5-in-diam solid cylindrical bar. Steady-state particle-velocity vectors were determined from gridded, split billets during incremental extrusion steps. These velocity patterns were compared with those obtained previously for lead extrusions having the same billet and die geometry and the same high degree of lubrication. It was found that the patterns for these two metals were identical. The aluminum velocity pattern appeared not to be affected by extrusion load, but the extrusion load was a strong function of the extent of deformation. It was estimated that the extrusion load becomes constant after a reduction of billet length by approximately 2.4 in., the distance the plastic zone of the metal ex-

tends upstream from the orifice. The axial-stress distribution in the billet, determined from strain rates and natural strains, taking into account work-hardening, had the same shape as that determined with lead. The wall pressure or radial stress in the plastic zone was found to be lower than the average pressure, but both pressures tend to approach each other beyond the plastic zone.

A Re-Evaluation of Surface Finish, by L. Chaney, Micrometrical Development Corporation, and C. H. Good, Mem. ASME, Micrometrical Manufacturing Company, Ann Arbor, Mich. 1954 ASME Annual Meeting paper No. **54—A-192** (multilithographed; available to Oct. 1, 1955).

During the past 15 to 20 years surface finish has come into prominence as one of the inspection criteria. It has the same purpose as any of the other inspection criteria, namely, to indicate whether the manufactured part will perform according to specification.

Surface-finish specifications have become a common marking on a print. The engineer has a general idea of when surfaces should be specified, and he has a general idea of how a finish can be achieved. However, in specific instances, he has to make either educated guesses or learn from experience before he can specify surface finish. There are no adequate guideposts for a really sure surface specification.

The engineer's problem is briefly stated in three questions: (1) What is the relationship between surface finish and performance? (2) What is the relationship between surface finish and machining methods? and (3) What is the relative importance of the various surface characteristics?

Temperature Distribution at the Tool-Chip Interface in Metal Cutting, by B. T. Chao and K. J. Trigger, Mem. ASME, University of Illinois, Urbana, Ill. 1954 ASME Annual Meeting paper No. **54—A-115** (multilithographed; available to Oct. 1, 1955).

A rapid, iterative method is presented for computing the distribution of temperature at the tool-chip interface. Calculation shows that the maximum temperature occurs at a point near the trailing edge of the contact when chips are produced at conventional feeds and speeds with sintered-carbide tools. The heat-flux distribution at the interface is also obtained.

The analysis reveals that, under the usual conditions, heat is being conducted from the tool into the chip over a small region close to the cutting edge. It also has been found that the thermal conductivity of the tool material has only small influence on the mean cutting temperature. Relatively more significant is the effect on the temperature distribution. The role which the interface temperature distribution plays in the formation of crater wear is pointed out.

Self-Excited Vibrations of Systems With Two Degrees of Freedom, by E. Saljé, Institute for Machine Tool and Management, Aachen, Germany. 1954 ASME Annual Meeting paper No. **54—A-204** (multilithographed; available to Oct. 1, 1955).

The paper investigates vibrations of systems with two degrees of freedom. First, the paper considers the dynamic behavior of a lathe spindle. Cutting conditions are of influence, and it can be demonstrated that a lathe spindle approximates vibrations in two degrees of freedom. Thereafter, a series of tests are described that were run with turning tools of relatively great overhang and with two degrees of freedom. Finally, the mathematical conception of self-excited vibrations is given.

Metals Engineering

Some Properties of the Heat-Affected Zone in Arc-Welded-Type 347 Stainless Steel, by E. E. Nippes and H. Wawrousek, Rensselaer Polytechnic Institute, Troy, N. Y., and W. L. Fleischmann, Mem. ASME, Knolls Atomic Power Laboratory, Schenectady, N. Y. 1954 ASME Annual Meeting paper No. **54—A-57** (multilithographed; available to Oct. 1, 1955).

This investigation was undertaken to establish the properties of Type 347 stainless steel in regions adjacent to arc welds mainly for a study of the effect of these properties upon the behavior of weldments at elevated temperatures.

Specific microstructures associated with definite regions of the weld heat-affected zone were produced synthetically on the RPI time-temperature controller. Samples with uniform microstructure were obtained in sufficient size that the usable test specimens could be prepared. These samples were then used to study some of the mechanical and metallurgical changes brought on by welding and as a consequence of postweld heat-treatment. The room-temperature impact strength exhibited a slight decrease in the samples heated to the highest peak temperature, 2500 F. The rupture test at 1100 F of specimens heated to 2400 F showed a significant decrease of ductility. To study the carbide precipitation occurring in the weld heat-affected zone upon exposure within the sensitization range, a series of as-welded specimens were given a 1200 F treatment. Those samples, which were originally heated to above 2400 F before the sensitization treatment, exhibited severe attack by boiling 65 per cent nitric acid.

Photomicrographs are presented showing the metallurgical changes in the weld heat-affected zone.

The Stress-Rupture Strength of Type 347 Stainless Steel Under Cyclic Temperature, by E. E. Baldwin, Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y. 1954 ASME Annual Meeting paper No. **54—A-231** (multilithographed; available to Oct. 1, 1955).

Stress-rupture tests of Type 347 stainless steel were conducted in liquid sodium under constant and cyclic-temperature conditions. Constant-temperature tests were conducted at temperatures between 1000 and 1200 deg F. Cyclic-test temperatures ranged from 416 to 1294 deg F and cycle times ranged from 6 to 12 hr.

It was concluded that the deviation of the test results from the rupture life calculated by the method of Robinson and Miller was due to transient creep of the steel under cyclic-temperature changes.

Biaxial Plastic Stress-Strain Relations of a Mild Steel for Variable Stress Ratios, by Joseph Marin, Mem. ASME, and Ling-Wen Hu, The Pennsylvania State University, State College, Pa. 1954 ASME Annual Meeting paper No. **54—A-243** (multilithographed; available to Oct. 1, 1955).

The main objective in the study reported in this paper was to provide further experimental checks on the validity of the simple flow theory of plasticity.

In this investigation biaxial stresses were produced by subjecting tubular specimens to internal pressure and axial tension. Tests were made on specimens machined from cold-drawn seamless-steel tubing. Most of the tests were performed under variable biaxial-stress ratios but in order to provide the necessary control data and basic biaxial strength properties, a series of constant stress-ratio tests also were conducted. Eight different types of variable stress-ratio tests were devised to determine the validity of the simple flow theory. Results of these tests do not support the theory.

A test also was made to check the validity of the distortion-energy criterion as used in the simple flow theory. The differences between the theoretical and experimental results for this test were too great to be explained as due to experimental error or material anisotropy.

A special variable stress-ratio test was conducted to compare certain requirements of both the slip and simple flow theory. Results from this test were in poor agreement with the simple flow theory and in approximate agreement with the slip theory.

An investigation was made to determine the validity of the so-called "loading function" as required by the various plasticity theories. These test results do not agree with the concept of a loading function.

Effect of Sequence on the Coefficient of Friction in Cold-Drawing Low-Carbon Steel and 2S-O Aluminum Rods—Part III, by H. Majors, Jr., Mem. ASME, University of Alabama, University, Alabama. 1954 ASME Annual Meeting paper No. **54—A-114** (multilithographed; available to Oct. 1, 1955).

This is Part 3 of three parts in which Part 1 discussed the cold-drawing of annealed SAE 1020 steel. Part 2 was concerned with the cold-drawing properties of 2S-O aluminum rods under various sequences of cold work.

For the various sequences in cold-working 2S-O aluminum and SAE 1020 steel, the average coefficients of drawing friction were determined by Sachs theory and by direct measurement using SR-4 wire strain gages on the outer surface of the die. Die profiles were determined by plastic castings. One-inch diameter rods were given a true reduction of area of various amounts up to 0.760 at drawing speeds of 2 ipm. Various sizes of dies were used to accomplish the reduction. After the rods were coated with Banox No. 5 solution, a paste made of Molykote powder and SAE 40 oil was used for lubricating the annealed steel while a paste made of Molykote powder and kerosene was used on the 2S-O aluminum.

A Method of Predicting the Effects of Notches in Uniaxial Fatigue, by W. E. Dirkes, Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio. 1954 ASME Annual Meeting paper No. **54—A-180** (multilithographed; available to Oct. 1, 1955).

The phenomenon of progressive fracture of metals under repeated loads, generally referred to as fatigue failures, has been investigated extensively, and the physical laws governing such failures are gradually being uncovered. A definition of the mechanism of failure is particularly difficult due to the large number of variables which have been found to affect test results. Significant contributions have been made by a great number of investigators. Much of the work to date has consisted of either empirical correlation of test data or the development of mathematical solutions which satisfy only special cases.

This paper approaches the problem of correlating notched and unnotched test data from observations of how the material may be considered to be affected under repeated stresses. A semigraphical method of extrapolating notched test data is developed.

Although data are not available to prove the observations reported, neither does presently available information refute the views presented. Individual observations are gathered together to form a picture which is intended as an aid to designers in visualizing possible trends even though complete test data are not available.

Design Aspects of High-Temperature Fatigue With Particular Reference to Thermal Stresses, by L. F. Coffin, Jr., Mem. ASME, Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y. 1954 ASME Annual Meeting paper No. **54—A-252** (multilithographed; available to Oct. 1, 1955).

Thermal transients in large high-temperature machines represent a serious problem for the designer. Examples include temperature gradients in large steam turbines with rapid start-ups, welds between ferritic and austenitic materials, complex pipe assemblies, and many others. Here temperature gradients or mismatch in expansion of structural materials or expansion under conditions of constraint lead to thermal stresses which may be quite severe. Plastic deformation may occur in such situations, which, if cyclic conditions prevail, can lead to cracking by fatigue in an otherwise ductile metal. The situation can be particularly severe in nuclear-power equipment.

Studies on thermal-stress fatigue have appeared in the literature in the past few years. More recently, an experimental investigation of one high-temperature structural material, Type 347 stainless steel, was carried out on a laboratory scale at the Knolls Atomic Power Laboratory. From the results of that study it was possible to formulate a mathematical relationship for predicting failure of the test specimens under constrained cyclic-thermal conditions. A later investigation showed that a similar relationship could be expressed for strain cycling to failure at constant temperature.

A criterion for fatigue failure has been proposed, based on experiments carried out on test specimens subjected both to constrained thermal cycling and constant-temperature strain cycling. This criterion relates the number of cycles-to-failure with the plastic strain change per cycle. The application of such a criterion to design, where thermal-stress fatigue is the principal factor, is discussed from fundamental and practical viewpoints. From such a criterion it is possible to predict the life of a certain machine part for a calculated thermal stress or, conversely, the thermal stress permitted for a certain limiting number of cycles of stress.

Quantitative Evaluation of Thermal-Shock Resistance, by S. S. Manson and R. W. Smith, NACA Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1954 ASME Annual Meeting paper No. **54—A-263** (multilithographed; available to Oct. 1, 1955).

The dependence of thermal-shock resistance on two parameters k and $\sigma_f/E\alpha$ (when k is conductivity, σ_f the fracture stress, E the elastic modulus, and α the coefficient of thermal expansion) is experimentally demonstrated by the fact that the relative ratings of two materials may change with a change of quench severity. The theory of thermal-shock resistance of a thin cylinder quenched at the periphery is developed, making use of the results of Jaeger. Two criteria for failure are considered: The maximum normal stress criterion and the criterion of maximum "risk of rupture" based on the Weibull Statistical Theory. Both result in approximately the same temperature difference between initial uniform disk temperature and coolant to cause fracture, but the Weibull theory suggests that for severe quenches fracture probably occurs at a later time than the time for maximum surface stress to be reached. Considerations of stress distribution at the instant of fracture also suggest that the proper fracture strength can be measured in a modified modulus of rupture test.

Equipment for subjecting these specimens to a wide range of quench severities of known surface heat-transfer coefficients is described, and results are presented for thermal-shock tests of steatite and glass disks. Results for steatite are then utilized for determination of thermal-shock parameters by four independent methods:

(*a*) Direct measurement of the individual physical properties utilizing simplified tests described; (*b*) direct measurement of conductivity, together with a single thermal-shock test at known condition of surface heat-transfer coefficient; (*c*) measurement of cooling curves at two or more radial positions, together with the temperature difference to cause fracture, utilizing a single condition of

known surface heat-transfer coefficient; and (*d*) measurement of temperature difference to cause fracture at two or more conditions of known surface heat-transfer coefficient.

Good agreement was obtained among the four methods.

Approximate Solution to Thermal-Shock Problems in Plates, Hollow Spheres, and Cylinders With Heat Transfer at Two Surfaces, by A. Mendelson and S. S. Manson, NACA Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1954 ASME Annual Meeting paper No. **54—A-264** (multilithographed; available to Oct. 1, 1955).

An approximate method for computing transient thermal stresses in hollow cylinders, plates, and hollow spheres is presented. The method makes use of polynomial approximations to the temperature distribution by means of which the partial differential equation of the problem is reduced to a set of first-order ordinary differential equations. Nonuniform initial temperature distribution and heat transfer from both surfaces can be treated without difficulty, making possible the practical solution of problems with relatively little labor for which an exact solution requires a great expenditure of labor and time.

Several examples are presented and compare favorably with more accurate solutions.

Fuels Technology

Industrial Boiler-Plant Design Factors, by C. E. Rodenburg, Mem. ASME, and J. M. Brown, Ford, Bacon & Davis, Inc., New York, N. Y. 1954 ASME Annual Meeting paper No. **54—A-116** (multilithographed; available to Oct. 1, 1955).

This paper is primarily a guide for management and operating personnel. The purpose is to stress the authors' conviction that boiler-plant design should be based on continuity of objective and policy. With such an approach one of the most severe limitations on the designer will be lifted. A design can be no better than the information on which it is based, according to the authors A continued policy and objective will improve the design through greater information.

For example, an industrial plant planning to expand production or replace an outdated plant is looking for a high-efficiency low-maintenance installation where investment costs run high. On the other extreme, a decision to enter a new field or take a flier on a new product may indicate the lowest possible first cost of investment. The plant design to meet these vastly different requirements is certain to reflect the magnitude of these differences.

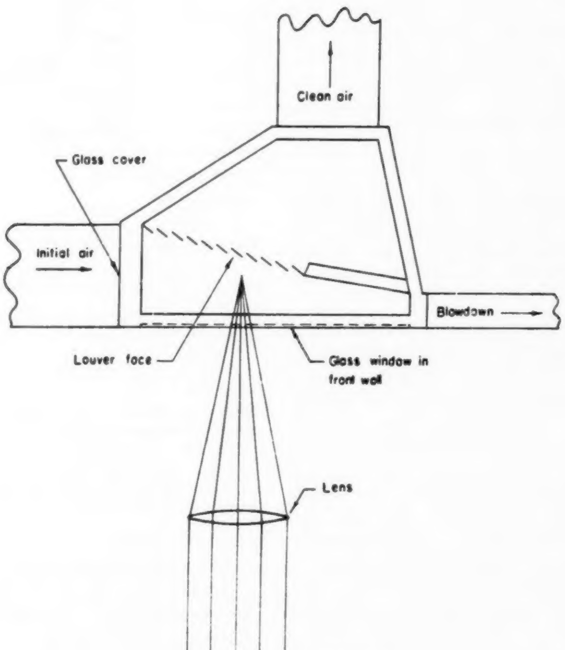
Similarly, the anticipated load demand is vital to sound design. A combined electric-steam service depends upon the mutual relationship between the two demands to produce an economic design. A gross error in demand data could produce a plant throttled to partial capacity by a bottleneck in an undersized auxiliary.

The Mechanism of Separation in the Louver-Type Dust Separator, by J. L. Smith, Jr., U. S. Army, Albuquerque, N. Mex., and M. J. Goglia, Assoc. Mem. ASME, Georgia Institute of Technology, Atlanta, Ga. 1954 ASME Annual Meeting paper No. **54—A-134** (multilithographed; available to Oct. 1, 1955).

A preliminary study of the particle paths in a two-dimensional louver separator was conducted to determine which design features are conducive to good performance. Throughout the investigation, the particle paths were made visible by reflected light.

The air-flow pattern through the separator was found to be the controlling factor in the performance; hence the shape of the housing on both sides of the louver is of utmost importance. The flow pattern with the same flow through each louver opening was found to be the most desirable. This flow pattern was present when the velocity of the blowdown portion of the inlet air stream was constant from inlet to blowdown. The effect of the per cent blowdown was correlated to changes in the air-flow pattern. It was found that the performance of the separator could be maintained at low blowdown flows if the louver housing was designed to provide a desirable flow pattern at the specified blowdown flow.

From the particle-path studies, it was concluded that an effective louver blade shape separates the region of particle impacts with the blade from the region



Two-dimensional louver separator with modifications for particle-path observations. It is characterized by a stream of dust-laden air incident upon a row of blades or vanes which form the louver face. The larger portion of the air stream, clean air, turns and passes through the blades and the smaller portion of the air stream, blowdown, continues in its original direction without passing through the louver face. The blades are so arranged that the dust because of its high inertia is unable to pass through the blades and is concentrated in the blowdown air stream.

where the air is passing between the blades. The particle-size studies showed that the separator was effective down to 10 microns and more effective on particles above 40 microns. The data showed that the per cent of the initial dust separated was essentially independent of the initial air velocity and of the initial dust concentration.

Typical Small and Medium Steam-Plant Designs, by T. D. Coyne, Gibbs and Hill, Inc., New York, N. Y. 1954 ASME Annual Meeting paper No. **54—A-205** (multilithographed; available to Oct. 1, 1955).

This paper presents a discussion of salient features of two typical industrial steam plants designed by the author's company. The objective is to extend the benefits of good engineering into small and medium-sized industrial steam-heating and process plants.

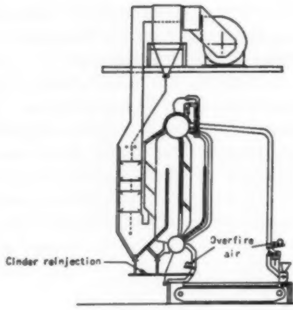
Designs have been developed for 35,000-lb-per-hr dump-grate, spreader-stoker-fired boilers and 60,000-lb-per-hr continuous-discharge, spreader-stoker-fired units. Although the layouts and specifications apply directly to these two sizes of steam generators, it is expected that the arrangements will be of use for installations within or approaching the capacity range indicated.

A Study of Spreader-Stoker Reinjection Systems, by W. C. Holton, Mem. ASME, Battelle Memorial Institute, Columbus, Ohio. 1954 ASME Annual Meeting paper No. **54—A-117** (multilithographed; available to Oct. 1, 1955).

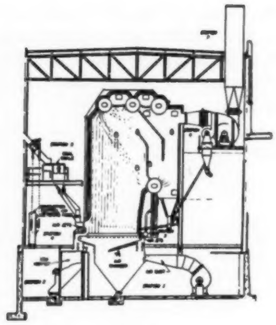
Reinjection of fly ash from spreader-stoker-fired boiler furnaces was initially a means of disposal of this material, but has come also to be regarded as a device for increasing boiler efficiency.

Results of tests on four units previously described in the literature are reviewed and compared in this paper. Two types of material balance on reinjection systems are described and illustrated to show that as much as 61 per cent of the noncombustible material in the reinjected fly ash may remain on the grate. In addition, calculations by both a material balance on the combustible matter in the reinjected fly ash and by a total combustible balance indicate that all of the combustible in the material reinjected can be burned. These calculations are roughly confirmed by the increased rates of collection of grate refuse found in tests with reinjection as compared with those of tests without reinjection.

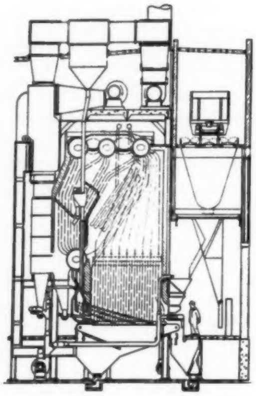
It is concluded that, although the present systems of reinjection are partly effective in burning or depositing the reinjected material on the grate, further improvements could be made to increase efficiency of reinjection.



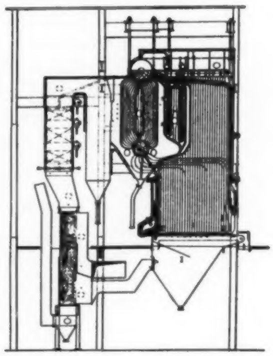
Combustion Engineering



Elyria



J. I. Case



Babcock and Wilcox

Description of Unit	CE	Elyria	J. I. Case	B & W
Rated Steam Capacity, lb per hr	100,000	60,000	100,000	160,000
Coal Fired: Type	Eastern bituminous	Ohio	West Virginia	Not
Size, in.	$1\frac{1}{4} \times 0$	$\frac{3}{8} \times 0$	2×0	given

Side elevations of four spreader-stoker-fired boiler units tested. Capacity of these boilers ranges between 60,000 and 100,000 lb per hr. Only two-drum and four-drum boilers are shown. Of the four shown, only the Babcock and Wilcox unit is completely water-cooled. All others have a refractory front wall. Different baffle arrangements are used in each unit, but the B & W example is a straight-through boiler without baffles.

Cleveland Co-Operative Meteorological and Air-Pollution Program, by H. J. Scott, Mem. ASME, Commissioner of Air Pollution Control, Cleveland, Ohio. 1954 ASME Annual Meeting paper No. **54—A-166** (multilithographed; available to Oct. 1, 1955).

Through the united efforts of 14 major industries, the U. S. Weather Bureau, and the Division of Air-Pollution Control of Cleveland, the relationships between air pollution and meteorological factors over a large industrial area have been and still are being studied. This program was conceived, organized, and placed in operation to determine, if possible, the effect of meteorological data on the concentration of air pollution. Sampling stations have been set up in an industrial area and simultaneously operated for extended durations over a three-year period.

This group adopted standard equipment and sampling methods, recorded air pollution and meteorological factors, and statistically analyzed these data as

to the relationships between air pollution and certain of these factors.

A method of forecasting the amount of air pollution is presented in this paper. The method involves: (1) A table or chart showing the main concentration with each wind direction, (2) correction factors for diurnal variations, (3) correction factors for the influence of inversions, (4) an accurate wind-direction forecast, and (5) a forecast of the time of occurrence and duration of inversions.

Suppression of Burner Oscillations by Acoustical Dampers, by A. A. Putnam, Mem. ASME, and W. R. Dennis, Battelle Memorial Institute, Columbus, Ohio. 1954 ASME Annual Meeting paper No. **54—A-174** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

Tests on the suppression of burner oscillations are described. The work produced several positive conclusions which may help in quieting particular combustion installations or in preventing waste of effort in trying ineffective methods.

The effectiveness of a quarter-wave tube was found to be critically dependent on length, but relatively insensitive to location, as long as the tube is placed in the region of the pressure antinode. Similarly, the effectiveness of a Helmholtz resonation depended critically on volume for a particular neck, but is quite insensitive to location. In neither case did the suppressor have to be placed near the particular antinode where energy was fed into the oscillation. The degree of suppression obtained was approximately proportional to the cross-sectional area of the tube. The same conclusion appears to be warranted with regard to the cross-sectional area of the throat of a Helmholtz resonator. Almost complete suppression was obtained with holes drilled in the side of the tube and placed within 10 per cent of a wave length from a pressure antinode. It was found that the diameter of the hole need not be greater than about $^1/_{10}$ to $^1/_{15}$ of the diameter of the combustion chamber, but should be greater than the wall thickness for best suppression.

High-Frequency Oscillations of a Flame Held by a Bluff Body, by W. E. Kaskan and A. E. Noreen, Mem. ASME, General Electric Company, Evendale, Ohio. 1954 ASME Annual Meeting paper No. **54—A-66** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

Experimental data are presented on the occurrence of flame-sustained transverse oscillations in a 2 × 4-in. duct with a V-gutter flameholder. The flame-speed versus flow-velocity field of burner operation was divided into an oscillation region and a nonoscillation region. The boundary line between the two was approximately described by an equation of the form

$$S_u U^{1.6} = \text{a constant}$$

where S_u is the laminar flame speed and U is the flow velocity. The oscillation was characterized by the formation of vortexes downstream of the flameholder tips. These vortexes distorted the flame front in such a way as to provide the driving force for the oscillation.

Flame-Stabilized Oxy-Fuel Gas Burners, by W. B. Moen, Mem. ASME, and T. L. Shepherd, Air Reduction Company, Inc., Murray Hill, N. J. 1954 ASME Annual Meeting paper No. **54—A-193** (multilithographed; available to Oct. 1, 1955).

An oxy-fuel gas burner characterized by extremely high rates of heat release and energy transfer to a workpiece is described. Design considerations necessary for optimum performance include a determination of favorable geometric configuration and fuel selection and operating conditions. Any applications, where rapid rates of heating are required, not within the confines of a furnace, are suggested.

Hydraulics

A Hypothesis of the Fluid-Dynamic Mechanism of Regenerative Pumps, by W. A. Wilson, Mem. ASME, M. A. Santalo, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass., and J. A. Oelrich, Assoc. Mem. ASME, Worthington Corporation, Harrison, N. J. 1954 ASME Annual Meeting paper No. **54—A-59** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

The term "regenerative pump" is used in this paper to denote a hydrodynamic unit often referred to as periphery pump, turbulence pump, friction pump, turbine pump, and the like. The main feature of this unit is that it develops in a single rotor high heads at low flow rates. Although its efficiency is not impressive, it is very good compared to other hydrodynamic pumps of comparable specific speeds, and it has found many applications in industry. The very low specific speeds of the regenerative pump have made it particularly attractive for lubrication, control, filtering, and booster systems.

A hypothesis of operation of the regenerative pump is presented which reflects the experimentally observed characteristics of the flow inside the pump. An analysis based on the hypothesis leads to a series of expressions for pump performance over the entire operating range in terms of only three empirical constants. A remarkable agreement between the theoretical performance and the experimental data for a commercial unit substantiates the hypothesis.

Model Tests of the 84-In. Tracy Pumps, by W. H. Fraser, Mem. ASME, Worthington Corporation, Harrison, N. J. 1954 ASME Annual Meeting paper No. **54—A-225** (multilithographed; available to Oct. 1, 1955).

In 1946 the author's company was awarded a contract by the Bureau of Reclamation to manufacture six seven-vane, end-suction impeller pumps in twin-volute casings, each capable of delivering 767 cfs against a total head of 197 ft when operated at 180 rpm. These pumps were to be used at the Tracy Pumping Plant to direct waters of the Sacramento River to the southern area of the Central Valley of California.

Design and tests of the model pump required to meet the specifications for the prototype are described.

Hydraulic-Turbine Design Problems, by John Parmakian, Mem. ASME, U. S. Bureau of Reclamation, Denver, Colo. 1954 ASME Annual Meeting paper No. **54—A-68** (multilithographed; available to Oct. 1, 1955).

This paper describes several serious deficiencies which were observed at various hydraulic-turbine installations. It includes an account of the causes leading to the failure of bolted bucket-type runners for impulse turbines, the excessive distortion of a large diameter stay ring for a Francis turbine, the objectionable vibration of turbine shafts at several installations, and a failure of a large diameter spiral case for a Francis turbine due to excessive bending in the stay vanes.

Through Flow in Concentric and Eccentric Annuli of Fine Clearance With and Without Relative Motion of the Boundaries, by L. N. Tao, Assoc. Mem. ASME, and W. Donovan, Assoc. Mem. ASME, Worthington Corporation, Harrison, N. J. 1954 ASME Annual Meeting paper No. **54—A-175** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

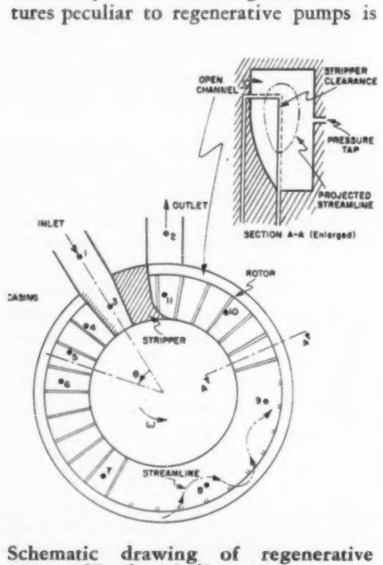
The problem of the through flow across annuli of fine clearance has been investi-

gated both theoretically and experimentally. The study includes the effects due to the relative motion of the walls and to varying degrees of eccentricity of the bounding surface. Experimental work was carried up to a Reynolds number, based on the diametral clearance of 30,000.

Theoretical results are presented both graphicallly and in the form of equations. Nomographs are included for rapid solution of certain engineering problems.

Relationship of Regenerative Pump Performance to Casing Geometry, by W. A. Wilson, Assoc. Mem. ASME, M. A. Santalo, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass., and J. A. Oelrich, Assoc. Mem. ASME, Worthington Corporation, Harrison, N. J. 1954 ASME Annual Meeting paper No. **54—A-60** (multilithographed; to be published in Trans. ASME, available to Oct. 1, 1955).

This paper deals with an experimental investigation of the effect of regenerative pump-casing geometry on the performance characteristics of the pump. Results are presented in terms of parameters consistent with the hypothesis of operation presented in a companion paper. The relationship of these parameters to the prior art of hydrodynamic machinery and to those geometric features peculiar to regenerative pumps is developed. Cognizance is taken of inlet and exit phenomena as well as of the characteristic mechanism of the pump.



Schematic drawing of regenerative pump. Numbers indicate pressure taps. The pump consists of an impeller with a large number of radial blades at its periphery. Flow enters the pump at point 1 and circulates repeatedly between the blades and the open channel. At point 11 a "stripper" prevents the pump flow from returning to the inlet. The pump flow is then discharged at point 2.

Stability of Umbrella-Type Vertical Water-Wheel Generators, by J. J. Hart, Mem. ASME, Westinghouse Electric Corporation, East Pittsburgh, Pa. 1954 ASME Annual Meeting paper No. **54—A-148** (multilithographed; available to Oct. 1, 1954).

Mechanical stability of vertical umbrella water-wheel generators is analyzed under normal and abnormal conditions.

Four typical umbrella generators of recent design are analyzed to indicate in a practical way the magnitude of the factors involved. Stability of these units is considered under the following five conditions: Normal operation under the influence of unbalanced magnetic pull; foundation settlement or growth; shaft deflection with a rigidly supported bearing; deflection of exciter rotors due to unbalanced magnetic pull; and critical speed with rotor raised off thrust bearing due to hydraulic forces.

Results indicate a large factor of safety maintaining generator stability.

On the Mechanism of Cavitation Damage, by M. S. Plesset, Mem. ASME, and A. T. Ellis, California Institute of Technology, Pasadena, Calif. 1954 ASME Annual Meeting paper No. **54—A-76** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

A new method for producing cavitation damage in the laboratory is described in which the test specimen has no mechanical accelerations applied to it in contrast with the conventional magnetostriction device. Alternating pressures are generated in the water over the specimen by exciting a resonance in the "water cavity." By this means the effects of cavitation have been studied for a variety of materials. Photomicrographs have been taken of several ordinary (polycrystalline) specimens and also of zinc monocrystals. The zinc monocrystal has been exposed to cavitation damage on its basal plane and also on its twinning plane. X-ray analyses have been made of polycrystalline specimens with various exposures to cavitation.

Results show that plastic deformation occurs in the specimens so that the damage results from cold-work of the material which leads to fatigue and failure. A variety of materials have been exposed to intense cavitation for extended periods to get a relative determination of their resistance to cavitation damage. It is found that, roughly speaking, hard materials of high tensile strengths are the most resistant to damage. While this survey is far from complete, it has been found that titanium 150-A and tungsten are the most resistant to damage of the materials tested.

Secondary Flow in Axial-Flow Turbomachinery, by L. H. Smith, Jr., Assoc. Mem. ASME, General Electric Company, Evendale, Ohio. 1954 ASME Annual Meeting paper No. **54—A-158** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

A method is presented by which the principal effects of secondary flow can be included in the design of multistage axial-flow turbomachinery. The method uses the conventional axial-symmetry solution as a basic flow picture from which the included turning and radial velocities characteristic to the secondary flow can be deduced. Frictional effects, such as the growth of boundary layers on the blades, are excluded from the analysis but the disposition of the fluid, which comes from boundary layers on the hub and casing surfaces upstream of a blade row, can be accounted for in an approximate manner by assuming that the fluid is frictionless while in the blading. To get a first-order approximation of the secondary flow in a blade row, it is only necessary to know the number of blades in the row and the axisymmetric-flow solution. The principal assumption involved in this approximation in that the distortion of the flow surfaces due to the secondary velocities is small. The method is sufficiently accurate for predicting the secondary flows which occur as a result of nonuniform blade loading, but solutions for boundary-layer flows must be considered only qualitative because of the large flow-surface distortions which are associated with these flows.

A Method for Analyzing the Stresses in Centrifugal Impellers, by J. W. Glessner, Assoc. Mem. ASME, Elliott Company, Jeannette, Pa. 1954 ASME Annual Meeting paper No. **54—A-167** (multilithographed; available to Oct. 1, 1955).

A method of analyzing the stresses in a rotating impeller is presented for a general case. The method is characterized by obtaining an elastic balance between the blades, disk, and cover, when these parts are subjected to centripetal acceleration.

Three examples with different blade flexural rigidities are calculated. By examining the results of these calculations,

an approximate, simplified method is suggested which may permit rapid solution of these problems.

Finally, an interesting special case is considered and the failure speed of the piece predicted. For this case, comparison of the failure speed predicted by calculation and actual spin-test data shows good correlation.

Turbulent Flow in the Entrance Region of a Pipe, by Donald Ross, Whippany, N. J. 1954 ASME Annual Meeting paper No. **54—A-89** (multilithographed; available to Oct. 1, 1955).

THIS paper presents an analytical solution for the turbulent, boundary-layer flow in the entrance region of a pipe. The equations yield the relative momentum thickness at any station within ten diameters of the entrance, and from this the pressure drop and head loss are calculated. The ratio of these quantities to the corresponding values for fully developed pipe flow are found to be practically independent of Reynolds number. Comparison of the theoretical expressions with the few data that are available shows good agreement, confirming the formulas for design applications.

Recent Investigations of the Mechanics of Cavitation and Cavitation Damage, by R. T. Knapp, Mem. ASME, California Institute of Technology, Pasadena, Calif. 1954 ASME Annual Meeting paper No. **54—A-106** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

THIS paper describes water-tunnel investigations into the mechanics of "fixed"-type cavitation and into the probable mechanism through which this type causes material damage. High-speed motion pictures were used to study the cavity mechanics, and indications of the damage pattern were obtained by measuring the pitting rate of soft aluminum test specimens.

Information was obtained on the frequency and intensity of the damaging blows, the distribution of damage in relation to the area covered by the cavitation, and the variation of the intensity of cavitation with velocity.

An Experimental and Analytical Investigation of a Differential-Surge-Tank Installation, by W. L. Gibson and W. Shelson, Hydro-Electric Power Commission of Ontario, Toronto, Ont., Can. 1954 ASME Annual Meeting paper No. **54—A-138** (multilithographed; available to Oct. 1, 1955).

PERFORMANCE of a differential surge tank was measured experimentally for various acceleration and retardation conditions, and the results were compared with those obtained analytically.

In the experimental investigation the dynamic pressures at several places in the hydraulic system, together with the turbine-gate positions, were recorded simultaneously on a multichannel oscillograph. For comparison, the corresponding water-hammer pressures and mass flows in the system were calculated by recognized step-by-step processes, adequate numbers of steps being made practicable by the use of high-speed digital computers. The calculated results agreed closely with those determined experimentally.

Momentum and Mass Transfer in a Submerged Water Jet, by Walton Forstall, Mem. ASME, and E. W. Gaylord, Assoc. Mem. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1954 ASME Annual Meeting paper No. **54—A-38** (in type; to be published in the *Journal of Applied Mechanics;* available to Oct. 1, 1955).

FOR a round water jet issuing into stationary water, momentum and material diffusion were measured, the latter by means of a sodium chloride tracer technique.

It was found that (*a*) the behavior of the water jet was the same as that found by others for an air jet issuing into air, and hence constants obtained from measurements in air can be applied to water; (*b*) the turbulent Schmidt number for water is approximately the same as the turbulent Schmidt number for air and about equal to the turbulent Prandtl number for air jets; (*c*) the error curve serves as a useful and satisfactory representation of diffusion profiles for water just as it does for air.

The Ultrasonic Measurement of Hydraulic Turbine Discharge, by R. C. Swengel, York, Pa., W. B. Hess, Mem. ASME, Safe Harbor Water Power Corporation, Conestoga, Pa., and S. K. Waldorf, Pennsylvania Water and Power Company, Lancaster, Pa. 1954 ASME Annual Meeting paper No. **54—A-54** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

TO OBTAIN the basic discharge data necessary for efficient hydroelectric operation, a new ultrasonic flowmeter has been developed and applied to the measurement of flow in large water passages. During the development period, extensive tests under varied conditions of flow were made in a passage, 5 in. × 9 in., using a weighing tank as the absolute standard. Accuracies of 1 per cent or less were achieved regularly with appreciably turbulent and nonuniform flow distributions, using river water of varying turbidity. Installation in a turbine intake, 16 ft × 25 ft, has demonstrated the practicality of the method and equipment.

Rubber and Plastics

Vibration and Shock Control: A Design Tool, by G. H. Billman, Mem. ASME, Lord Manufacturing Company, Erie, Pa. 1954 ASME Annual Meeting paper No. **54—A-202** (multilithographed; available to Oct. 1, 1955).

THE paper treats the subject of vibration and shock control as related to product design. It is shown how, through application of engineered suspension systems, material savings, improved performance, and longer product life are realized. Attention is given to the variety of control systems and products, the design of which represents marked engineering achievements.

The Effect of Pulse Shape on Simple Systems Under Impulsive Loading, by C. E. Crede, Mem. ASME, The Barry Corporation, Watertown, Mass. 1954 ASME Annual Meeting paper No. **54—A-203** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

THIS paper proposes modified parameters for presenting "shock spectra" for elastic systems acted upon by acceleration pulses. It is shown that the ratio of maximum response acceleration to maximum acceleration of the pulse is a function of the pulse shape. By introducing velocity change (impulse or change in momentum) in place of maximum acceleration of the pulse, the influence of pulse shape on the spectrum is materially reduced. Significance of the spectrum for lightly damped systems is considered, where failure may result from fatigue after many cycles of stress reversal, induced by a single pulse.

Impact and Longitudinal Wave Transmission, by E. A. L. Smith, Mem. ASME, Raymond Concrete Pile Company, New York, N. Y. 1954 ASME Annual Meeting paper No. **54—A-42** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

THE necessary formulas for a numerical method of calculations are derived without the use of calculus or other advanced mathematics. An illustrative problem is solved in complete detail. Eight different types of impact are discussed.

Methods are given for taking account of friction, damping, coefficient of resti-

tution, plastic flow, and gravity. Branched systems are discussed briefly. Methods are given for checking results.

Experimental Technique for Predicting the Dynamic Behavior of Rubber, by Richard Dove and Glenn Murphy, Mem. ASME, Iowa State College, Ames, Iowa. 1954 ASME Annual Meeting paper No. **54—A-41** (multilithographed; to be published in Trans. ASME; available to Oct. 1, 1955).

An experimental technique is presented for evaluating those mechanical properties of materials which permit the prediction of the stress-strain diagram associated with a given strain-time diagram. Particular attention is given to the unrelaxed or dynamic modulus of elasticity and the relaxed modulus. It is shown how the energy loss for a cycle of loading and unloading depends on the rates of straining and unstraining as well as on any elapsed time between the straining and unstraining.

Equipment and equations necessary to evaluate the properties and make the predictions are discussed. Several predicted stress-strain diagrams are compared with diagrams constructed from direct observations.

Applied Mechanics

Stresses Due to Diametral Forces on a Circular Disk With an Eccentric Hole, by A. M. Sen Gupta, Bengal Engineering College, West Bengal, India. 1954 ASME Annual Meeting paper No. **54—A-37** (in type; to be published in the *Journal of Applied Mechanics*).

In this paper stresses in a circular disk with an eccentric circular hole have been determined when the disk is compressed along the line of centers by two equal and opposite forces acting on its outer edge, the inner edge being unstressed.

From the results obtained, the solution of the problem of a semi-infinite plate acted on by a concentrated normal force on its straight boundary and containing an unstressed circular hole has been deduced.

ASME Transactions for March, 1955

The March, 1955, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members; $1.50 to nonmembers) contains:

Technical Papers

Propagation of Elastic Impact in Beams in Bending, by Martin Goland, P. D. Wickersham, and M. A. Dengler. (53—A-46)

Oil Streamlines in Bearings, by C. F. Kettleborough. (54—A-23)

Synthesis of the Surfaces of Friction Skew Gears, by J. S. Beggs. (54—A-16)

Application of the Electronic Differential Analyzer to the Oscillation of Beams, Including Shear and Rotary Inertia, by C. E. Howe and R. M. Howe. (54—A-18)

Influence Coefficients for Hemispherical Shells With Small Openings at the Vertex, by G. D. Galletly. (54—A-4)

Membrane and Bending Analysis of Axisymmetrically Loaded Axisymmetrical Shells, by G. Horvay and I. M. Clausen, (54—A-8)

Small Rotationally Symmetric Deformations of Shallow Helicoidal Shells, by Eric Reissner. (54—A-13)

Two-Dimensional Flow About Half Bodies Between Parallel Walls, by J. P. Breslin. (54—A-3)

Turbulent Jet Mixing of Two Gases at Constant Temperature, by S. I. Pai. (54—A-1)

Plastic-Rigid Analysis of a Special Class of Problems Involving Beams Subject to Dynamic Transverse Loading, by M. F. Conroy. (54—A-17)

Forced Motions of Timoshenko Beams, by G. Herrmann. (54—A-6)

The Stress Problem of Vibrating Compressor Blades, by J. R. Schnittger. (54—A-21)

Experimental and Theoretical Study of Transverse Vibration of a Tube Containing Flowing Fluid, by R. H. Long, Jr. (54—A-22)

An Approximate Theory of Lateral Impact on Beams, by B. A. Boley. (54—A-24)

Anisotropic Loading Functions for Combined Stresses in the Plastic Range, by L. W. Hu and Joseph Marin. (54—A-9)

Axially Symmetric Flexural Vibrations of a Circular Disk, by H. Deresiewicz and R. D. Mindlin. (54—A-15)

The Effect of Elliptic Holes on the Bending of Thick Plates, by P. M. Naghdi. (54—A-26)

A Refinement of the Theory of Buckling of Rings Under Uniform Pressure, by A. P. Boresi. (54—A-2)

Gravitational Stresses in a Circular Ring Resting on Concentrated Support, by Yi-Yuan Yu. (54—A-7)

Harmonic Oscillations of Nonlinear Two-Degree-of-Freedom Systems, by T. C. Huang. (54—A-19)

Cylindrical Shells: Energy, Equilibrium, Addenda, and Erratum, by E. H. Kennard. (54—A-10)

Remarks on Donnell's Equations, by Joseph Kempner. (54—A-28)

Temperature Distribution and Efficiency of a Heat Exchanger Using Square Fins on Round Tubes, by H. Zabronsky. (54—A-12)

Approximate Stress Functions for Triangular Wedges, by I. K. Silverman. (54—A-14)

Brief Notes

Clamped Semicircular Plate Under Uniform Bending Load, by S. Woinowsky-Krieger.

On the Orthotropic Half Plane Subjected to Concentrated Loads, by H. D. Conway.

Discussion

On previously published papers by E. H. Lee and S. J. Tupper; M. L. Baron and H. H. Bleich; C. C. Chang and W. H. Chu; N. G. Wu and C. W. Nelson; J. N. Goodier and C. S. Hsu; N. J. Taleb; G. Horvay and I. M. Clausen; P. M. Naghdi and J. G. Berry; A. H. Shapiro and S. J. Kline; Y. Y. Yu; A. W. Cochardt; G. Herrmann; S. Woinowsky-Krieger; and A. M. Wahl, G. O. Sankey, M. J. Manjoine, and E. Shoemaker.

Book Reviews

How to Order ASME Papers

Copies of ASME technical papers digested this month are available in pamphlet form. Please order only by paper *number;* otherwise the order will be returned. Orders should be addressed to the ASME Order Department, 29 W. 39th St., New York 18, N. Y. Papers are priced at 25c each to members; 50c to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. The coupons, in lots of ten, are $2 to members; $4 to nonmembers.

Note: No digests are made of ASME papers published in full or condensed form in other sections of Mechanical Engineering.

Copies of all ASME publications are on file in the Engineering Societies Library and are indexed by the Engineering Index, Inc., both at 29 West 39th Street, New York, N. Y.

ASME Transactions and the *Journal of Applied Mechanics* are on file in the main public libraries of large industrial cities and in the technical libraries of engineering colleges having ASME Student Branches.

ASME Order Department
29 W. 39th St., New York 18, N. Y.

Date..................

Please send me the papers indicated by the following circled numbers:

54—A-37	54—A-106	54—A-173
54—A-38	54—A-107	54—A-174
54—A-41	54—A-108	54—A-175
54—A-42	54—A-110	54—A-178
54—A-50	54—A-112	54—A-180
54—A-51	54—A-113	54—A-190
54—A-52	54—A-114	54—A-192
54—A-53	54—A-115	54—A-193
54—A-54	54—A-116	54—A-202
54—A-56	54—A-117	54—A-203
54—A-57	54—A-118	54—A-204
54—A-59	54—A-122	54—A-205
54—A-60	54—A-123	54—A-225
54—A-61	54—A-124	54—A-231
54—A-64	54—A-134	54—A-243
54—A-66	54—A-138	54—A-244
54—A-68	54—A-139	54—A-250
54—A-76	54—A-148	54—A-252
54—A-89	54—A-158	54—A-261
54—A-98	54—A-161	54—A-262
54—A-101	54—A-164	54—A-263
54—A-104	54—A-166	54—A-264
	54—A-167	

Name..............................

Address............................

☐ Remittance enclosed ☐ Bill me
☐ ASME Mem. ☐ Nonmem.

Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Industrial Turbines

Comment by H. D. Harkins[1] and M. L. Jones[2]

The projected industrial steam-electric plant, which is the subject of this paper,[3] is usually required to demonstrate the high return on its investment that is expected of manufacturing equipment. Hence it is necessary that we examine such installations in detail in an effort to reduce the installation costs so that such units can be competitive in today's market.

Reducing Installation Costs

A scrutiny of the installed cost of such utilities is very much in order at this time. We, who design, install, and use such units, have in the past few years attempted to reduce the installed cost of such installations by various means within our control. This includes (1) reduction or elimination of building, (2) reducing aisles and nonproductive areas, (3) simplification of piping by employing the unit system, and (4) use of condenser shell as turbogenerator foundation and various other cost-reduction items.

We might now ask ourselves if additional cost reductions can be made in the major equipment, namely, the turbogenerator unit. One method is standardization. Standardization is a highly effective tool in reducing not only the cost of the equipment, but also design and construction costs. Therefore it is quite proper that further standardization of industrial turbogenerators be promoted. However, if any product is standardized before low-cost designs have been thoroughly explored and cost reductions achieved, we have put ourselves in the predicament of having frozen a high-cost situation and defeated the main objective of standardization. The 5000-kw turbogenerator cannot usually compete with its 50,000-kw brother if it is designed and built on the same basis.

[1] Supervising Engineer, Engineering Department, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. Fellow ASME.

[2] Power Engineer, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. Mem. ASME.

[3] "Future Industrial Turbine and Its Application," by H. Steen-Johnsen, Mechanical Engineering, vol. 76, September, 1954, pp. 727–730.

The industrial designer must frequently be very resourceful and explore many alternative heat balances in order to achieve high economy and put his proposal across the "necessary return" deadline. It would be unwise to limit his choice of sizes, pressures, and temperatures. If size, capacity, pressure, and temperature are to be standardized, it is hoped that some rational system of preferred numbers (such as ASA) be followed.

It appears to us that additional cost-reduction work need be done before the industrial turbogenerator is standardized. Current designs need to be questioned in all particulars. Why do we need elaborate foundations? Why can't we use a simple foundation similar to that used by manufacturers on their test-floor installations? If the direct-connected exciter is expensive to weatherproof, why not install an alternative device in the control room? Is a 3600-rpm turbine more economical to build than a higher-speed turbine with a gear reducer? What increase in operating efficiency can we realize with, say, a turbine operating at 7200 rpm or higher?

Vertical-Design Turbogenerator

In the search for a low-cost turbogenerator we should not ignore the old vertical design. The factors which made it obsolete may no longer exist. Accessibility for repairs is no longer important now that dismantling is needed only once in three to five years. It is ideal for setting on a ground-level foundation. Modern crawler cranes can dismantle it when necessary. (The author's dream of a water-lubricated bearing inside the condenser could be more readily realized in a vertical design where only a guide bearing is necessary at the lower end.) But the typical industrial job is noncondensing, so what's wrong with verticals?

Let's do some original constructive engineering on industrial turbogenerator installations and not standardize before we have cut present costs in half! There are many potential installations which can be justified and will be installed if the required investment can be reduced substantially. We hope that equipment manufacturers will rise to this challenge.

Auxiliary Drive Machines

The industrial turbine which is used for driving fans, pumps, blowers, refrigeration compressors, and the like, also can stand some investigation. On auxiliary boiler equipment such as fans and boiler feed pumps, which are speed-controlled by boiler instrumentation, why do we need elaborate oil governors with their small ports and passages? Why not have the simplest type of governor or possibly no governor at all? The recent trend toward limiting the amount of stress or thrust from steam-inlet and exhaust piping by manufacturers has resulted in expensive piping around units. Is this a real problem? Some units which were built and installed 25 years ago would not run according to today's design requirements.

The elimination of water cooling for the larger industrial turbines would help in reducing installed costs as well as to simplify the use of such units for outdoor service which is the present-day trend.

Relief Valve

The industrial turbine usually has a sentinel valve for indicating high back pressure in the casing. Why don't we build the relief valve in the casing as an integral part of the unit? This would reduce the field-erection costs of an installation which today is expensive at best. Also, it would be desirable if an industrial turbine had a built-in diaphragm control valve for steam to be used with auxiliary controls to eliminate the field installation of such equipment.

In summary, we, who are installing industrial turbines and industrial turbogenerators, are endeavoring to reduce the installed costs of such units, and we believe that some original thinking and co-operation of manufacturers will assist us in making such installations more competitive than they are today.

Comment by R. W. Worley[4]

The author has presented possible advancements in both design and application of steam turbines for the industrial field which provide much food for thought both for plant designers and users.

One of the most promising possibilities from an over-all economic standpoint is the standardization of oper-

[4] Engineering Manager, United Engineers & Constructors, Inc., Philadelphia, Pa. Mem. ASME.

ating steam conditions. This has long been a much-discussed goal of both turbine manufactuers and plant designers, with the expectation that resulting reduction in manufacturing cost and plant-design variation would present a sizable saving in capital expenditure per unit of power. The successful application of such standards in the central-station field has well demonstrated the possibilities of this type of program.

Standardization Possibilities

Those familiar with the wide scope of industrial processes and their turbine requirements, however, will recognize that standardization as complete and limiting as that possible in central-station practice would not be feasible. There is, without question, an optimum intermediate level of standardization from which many benefits would accrue to both manufacturer and user. Such standards cannot be determined by either party alone but should result from a thorough study by a committee capable of representing all interested groups.

Comments are made in the paper relative to industry's apparent reluctance to accept advances in temperatures and pressures. This impression is often a result of the turbine manufacturers' custom of viewing industrial-turbine applications as either one of two categories. In the words of the author, these are either "direct mechanical drive" or "turbogenerators for generating electrical energy." Actually, both of these applications must be subdivided to reflect primary purpose and characteristics of the application.

Mechanical Drive

A mechanical-drive turbine primarily installed as a source of motive power, operating condensing, or supplying a limited steam demand, in all probability would warrant a high level of design efficiency, or low steam rates resulting from high initial conditions. Even this application would be modified if fuel is inexpensive as a result of location or a by-product of a process.

When the drive is utilized purely as a steam-pressure reducing valve, with power as a by-product, supplying relatively large process-steam demands, high efficiency and initial conditions are apt to lose their attractiveness. This is particularly true when steam demand is just balanced with or overbalances power requirements.

The power-generation application is similarly affected by demand and ultimate utilization of extracted or exhaust steam.

Outdoor-Turbine Installations

Outdoor-turbine installations have been utilized successfully in industry for quite a number of years, especially in the petroleum and chemical fields. These installations were usually limited to single-stage and smaller multistage mechanical-drive applications in which weatherproofing is not a particularly costly or difficult problem, even if required; neither is continuous operator attendance necessary.

In the relatively recent attempts to extend the economic benefits of outdoor installation to larger mechanical drives, and particularly to electrical generating units, a number of complications have arisen. The author has presented means being employed by his company for weatherproofing such units, principally from the standpoint of water protection. Additional information would be of interest relative to protection against dust infiltration into lubricating and governing systems, and into other moving parts such as valve stems and glands.

It is assumed that the author's statement, "erection of an outdoor machine takes considerably more time than erection of an indoor unit," reflects time-out periods due to inclement weather and additional operations due to weatherproofed construction. Otherwise, it would be expected that with adequate erection planning, the net man-hours would compare closely for the two types of installation.

Operation of Outdoor Units

The completely outdoor plant can well present problems relative to operating-personnel morale, degree of operating attention, and pay scale. This is particularly true if seasonal weather variations are great.

Obviously, there are economic advantages to power plants of semioutdoor to fully outdoor characteristics, subject to prevailing weather conditions. A full study of the experience data of these earlier installations, such as presented by the author, will ultimately produce a rationalized answer to the problem.

Speed Regulation

The data presented on governing systems are of considerable interest as reliable speed regulation is the key to success in many industrial processes. Experience records on the life and aging characteristics of the rubber bushings supporting the governor weight pins, shown in Fig. 21 of the paper, would be of interest.

It is to be regretted that no particular developments are reported on governors for the smaller single stage, single-valve machines. Most users of these smaller machines can vouch for the need of more positive speed regulation, especially on variable-speed applications, and for more reliable overspeed protection.

The projected developments of high-speed geared units, high-temperature, high-pressure units, and water lubrication have some very interesting aspects. Many potential users will welcome progress reports on these development projects.

Comment by F. G. Feeley, Jr.[5]

Apparently but little consideration is being given to the single-stage mechanical-drive turbine. In fact, it has been said that no basic change has been made in this machine for more than 20 years and no particular change is expected. Our usage of this type of machine confirms the first part of this statement but also makes it apparent that the second part is not in accord with the needs of industry. We have found—as have others in utilities and industry—that the availability of certain heavy-duty pieces of equipment, particularly boiler feed pumps, has been improved to the point that absolute freedom from maintenance can be had for periods of eight to ten years and possibly longer.

The Single-Stage Turbine

A number of things are wrong with presently available single-stage turbine drives:

1 Although governors have been improved, steam-valve designs have inadequate motor power and the stems are not strong enough to withstand additional motor power, if it were available.

2 Casing joints, although supposedly capable of maintaining tightness metal-to-metal, cannot be made tight at high back pressures and high steam temperatures without the use of tape and sealing compounds.

3 Carbon packing rings require great care in fitting and even then will not run a full year—as is required in boilers in our industry, where continuous runs of 50 weeks are common. To make such a run possible, we have had to install eductors on carbon packing-ring drains and these frequently become overloaded toward the end of the run.

4 We have tried labyrinth-packed turbines and found them superior to carbon rings but the construction details of

[5] Design Engineer, Carbide and Carbon Chemicals Company, Division of Union Carbide and Carbon Corporation, New York, N. Y. Mem. ASME.

the presently available labyrinths are excessively complicated and steam leakage frequently occurs at the split joint even though the packing itself may be generally tight.

5 Overspeed trips are generally of excessive sensitivity causing unnecessary equipment outages and—resulting more often than not in operators deliberately disabling the device—preferring the remote chances of a turbine accident to the ever-present possibility of a turbine outage from a false move by a painter, electrician, insulator, or other careless hand. An overspeed device which will control a turbine without causing it to drop its load is urgently required and most certainly within the capability of industry to produce.

6 A great many industrial applications require no speed governors. A manufacturer should be prepared to offer, at low cost, a turbine whose design has not been compromised to provide for application of a governor.

7 Turbine blading and nozzle materials have kept pace with modern metallurgy to the point that mechanical-drive turbines are almost never involved in blading failures. Since cleaning can be accomplished by washing, the retention of complicated unwieldy shaped joints to provide supposedly "easy" blade and nozzle inspection is no longer justified.

8 There is not available—at a price commensurate with larger machines—a good mechanical-drive turbine in the very small range of sizes—a few horsepower up to 50 hp.

We believe a superior mechanical-drive turbine can be built by utilizing a large pedestal containing, in a thoroughly lubricated atmosphere, two radial bearings, a thrust bearing, overspeed trip, and a governor, if necessary. This would support an overhung rotor whose casing would be an essentially flat plate equipped with steam nozzles and a labyrinth gland—fitted from within; with the steam-reversing buckets mounted in place on the cover and with the housing completed by a hemispherical head containing the exhaust connection. Such a machine, while involving design work, would be of particular interest because of the freedom from "fussy" joints—since all would be circular; all lubricating-oil piping, coolers, etc., would be confined in a solid structure, shaft-packing leakage would be halved, and no loss of efficiency need be incurred. Machines of this general nature are built for Navy forced-draft-fan drives in great numbers. Although these are vertical machines, the principles of construction would be applicable to horizontals. We have some in service and their availability and freedom from maintenance has been outstanding. We challenge industry to create such a machine, and we are asking urgent consideration of other users in promoting its achievement.

Comment by J. S. Erichson[6]

Electric power for an industrial plant may be furnished in the following five general ways:

1 Complete purchased service.
2 Complete private plant.
3 Complete private plant with utility stand-by service.
4 Operation of a private plant in parallel with the utility system.
5 Operation of a selected part of the industrial plant load on the utility system, and the remainder of the plant load on a private plant.

The electric rates of the writer's company are such that most of the industrial concerns located in our territory do not find it economical to generate any of their own power but purchase the entire requirements from our supply.

Process Steam

However, in some large plants the process-steam requirements are large, such as in paper mills, chemical plants, and some textile mills. Also, some plants such as steel mills and oil refineries have large amounts of waste heat available. In such plants, a careful analysis of the power load and steam requirements should be made in order to determine if it is economically sound for the industrial concern to generate part of its power requirements.

Should such plants, or similar plants, wish to determine if the conditions of operation warrant parallel operation, a thorough analysis of the power load and the steam requirements should be made in order to determine if it is economically sound to generate part of the power requirements.

Heat Balances

In general, the electric load of a factory or mill usually grows faster than the steam load, and hence the heat balance requires attention with each major change in load.

Should a factory or mill now have a power plant operating, and conditions change, or power and/or steam requirements change, a complete analysis should be made before new electric or steam-generating equipment is purchased, in order to decide if it would be advantageous to purchase the additional load or even the additional load and part of the existing load. The latter arrangement possibly could eliminate the necessity of purchasing new steam-generating boilers.

[6] Service Engineer, Philadelphia Electric Company, Philadelphia, Pa.

Cutting Operating Costs

With the operating costs high as they are today, an industrial plant should look into all possibilities available to cut down costs. Two ways of cutting down on power-plant operating costs in present-day plants or new plants is by installing waste-heat reclaimers, and by the reduction in maintenance costs on material, and for labor.

Parallel Operation

Parallel operation of an industrial power plant with the utility requires paralleling and relay panels. Among the many relays which may be required for parallel operation are those for the detection of overloads on customers' generators, to detect faults, to provide automatic reclosing, and to detect grounds.

There are some plants on our service which do not operate in parallel with us, but purchase a specific block of power to operate a part of the production equipment. While this type of operation approaches a heat-balance condition, it does not give the economical operation obtained under parallel operation.

Author's Closure

As means of reducing installation cost, use of the condenser shell as a foundation is mentioned by Messrs. Harkins and Jones. Condensers built in this manner are quite expensive and sometimes it may be a toss-up if the foundation, that is eliminated by this means, is not as economical as the expensive condenser construction. In many instances we feel that cost of foundation can be reduced by reducing the height considerably. The condenser diameter can be reduced by making it longer and the condenser neck can be flared more than usual; by these means a substantial reduction in height is possible. For semioutdoor stations the long condenser has no tube-removal problem.

On the question of 3600 rpm versus higher-speed gear turbines it is possible that the higher-speed turbines may prove more economical but this would only be so after geared turbines were accepted generally by industry. The higher-speed turbines in sizes of 3 to 6000 kw probably will show up with somewhat better efficiency because the blading will be operated at higher speed and more com-

pletely filled with steam. This is particularly true when steam pressures are increased to the 900-psi level.

It is true that in a vertical-shaft turbine the journal bearings would act only as guide bearings; however, in this type machine, the thrust bearing would require considerable investigation because of the heavy load and the high speed.

The ruggedness of machines built 25 years ago is mentioned as a means of having a unit that can withstand extreme piping strains. If the steam pressure remained around 100 psi and temperatures around 400 F such designs would still be practical. For higher pressures and temperatures these older designs have what we might say is the mass in the wrong place. The temperature distortion within such a machine would be considerable if it were subjected to 750 F steam. The machines we build today probably could be made to withstand higher-piping strains than we would allow, but this would be a less economical unit to build and what might be saved in piping design might be expended for turbine design.

In reply to Mr. Worley's discussion of outdoor installations, the correct interpretation of the additional time required is that this added time is entirely due to shutdown of erection operations as a result of bad weather. Some additional construction time is required because of the weatherproof features but this in itself is a small percentage in proportion to the total time which is required for erection.

The basic mechanical-drive turbine with a mechanical governor is a relatively simple piece of equipment designed for everyday use around power plants and refineries. If it is required to have a sensitive governor on these machines, they can be equipped with the same governor that we use on the generator-drive turbines; that is, they can be equipped with a different bearing case and a governor of the vertical oil-relay type which will give precise speed control. Such installations frequently have been made where the machine is used to drive some piece of process equipment that needs close speed control, for instance, a paper mill or a spinning machine.

H. Steen-Johnsen.[7]

[7] Chief Engineer, Turbine Division, Elliott Company, Jeannette, Pa.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

The Dilworth Story

The Dilworth Story: The biography of Richard Dilworth, pioneer developer of the diesel locomotive. With a foreword by Charles F. Kettering. By Franklin M. Reck. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Ont., Can.; London, England, 1954. Cloth, $5^{1}/_{4} \times 8$ in., illus., x and 105 pp., $3.

Reviewed by C. B. Peck[1]

The biography of Richard McLean Dilworth, retired chief engineer of the Electro-Motive Division of the General Motors Corporation, is the story of a man with no formal education who played an important role in shaping the development of diesel-electric road locomotives in America. Born in Seattle in 1885, his father was a roving frontier minister and the only education available was such as his parents could give him at home. This leaned toward the classical side and taught him "respect for words" which, in his later career, he used with an ear for exact meanings. Moved to New York when he was 12, a licking in a fight at recess on his first—and only—half day at school, followed by another from the teacher for being in a fight, was too much and he ran away from home. Large for his age, he spent six years of wandering from job to job. During this period he was a roustabout for a circus; he went to sea; he "stole the trade of machinist" by watching and questioning others (he attracted the friendship of older men); in the same way he picked up the beginning of an electrical education as a telephone lineman. This period ended when he enlisted as an electrician in the Navy, from which he was discharged as chief electrician.

That a boomer mechanic should attain the position of influence in a pioneer engineering development which Dick Dilworth attained implies the possession of some unusual qualities of character. Throughout the formative years of his life one of these qualities was repeatedly demonstrated. While Dilworth recalls no particular desire to become a machinist, having taken the job with optimistic claims as to his training for it, its intricacies challenged him. Learning the value of a machinist's handbook, he found that its use required a knowledge of trigonometry and that he would have to study arithmetic and algebra before he could understand trigonometry. Enlisting in the Navy as an electrician because he found that a machinist in the Navy "had to work," he learned of Ohm's law from its three symbols tattooed on the back of a fellow sailor's hand. Dilworth never studied anything for which he had no immediate use, but the process of going back to fundamentals whenever he was faced with a problem requiring an expansion of his book knowledge, often repeated, called for a courage and determination not possessed by many men. Another characteristic demonstrated in his later career was his objective appraisal of the unusual events and personalities encountered during his unconventional early career and the practical wisdom he was thus able to bring to bear on his dealing with men at all levels, which was usually forthright and forceful.

His real career began when, at the age of 24, he was discharged from the Navy. Hired by General Electric as a machinist, he became engaged in the development of that company's gasoline-electric rail motorcar. From this point on, his entire career was associated with some phase of the development of automotive-type motive power for railroad use. He worked on the test floor; he delivered cars to railroads, where he came in intimate contact with railroad operation; he helped on the development of the first diesel engines designed and built in the

[1] Consulting editor, *Railway Locomotives and Cars*, Simmons-Boardman Publishing Corporation, New York, N. Y. Fellow ASME.

United States. Then, in 1926, he joined H. L. Hamilton's Electro-Motive Corporation as chief engineer. And, when General Motors took over the Electro-Motive Corporation and the Winton Engine Company, with which Dilworth had been working in the development of gasoline and distillate engines, the stage was set for the application of the diesel. From this time on Dilworth's consuming ambition was to establish diesel locomotives as the main-line motive power for both passenger and freight services.

With the advent of the articulated diesel-electric streamliners in 1934, the application of diesel power to road locomotives was on its way. The author tells of the part played by Dilworth in steering the development into channels of standard locomotive units, housed in cabs, patterned after the boxcar carried on swivel trucks, and keeping the design in the hands of the builder. For example, during the years when the Union Pacific and the Burlington were ordering new diesel-driven trains, the power-car design was usually subjected to a critical examination by a group including representatives of the electrical companies, the car builders, and several specialists of the railroad. Dilworth dreaded what might happen if each group of experts began to offer advice on how to improve the power car. "I played 'em a dirty trick, and to this day I don't think any of them has ever discovered it," he says. "I'd make a practice of inserting a glaring error into the layout. I'd put it in a prominent place where it would be sure to attract everybody's attention. This would start a debate over how to correct the error, and I didn't hesitate to keep the debate going by any means at hand. Sometimes the argument lasted for 12 or 15 hours, and by that time everybody would be so exhausted that they'd adopt the balance of the layout without further talk."

Mr. Reck gives a complete account of Mr. Dilworth's career as an engineer and sketches somewhat less in detail the various phases of the physical development of automotive power and its application to railway traction. But, essentially, he is telling the story of a colorful and salty personality. This he does with a wealth of incident and anecdote. In setting forth Dilworth's accomplishments, however, he has been over inclusive. An articulated rail car was built for the Santa Fe by the Pullman-Standard Car Manufacturing Company, for the design of which the Electro-Motive Corporation and Mr. Dilworth were responsible.

"Up to this time," says the author, "common railroad practice called for attaching the brake cylinder to the bottom of the car. However, on the distillate power car, it was also necessary to have the fuel tank attached to the bottom. . .

"So Dilworth conceived the idea that the large brake cylinder should be broken up into small cylinders and 'draped around the truck as close as possible to the brake shoes on the driving wheels.'" Apparently Mr. Dilworth had difficulty in selling the use of this idea to the customer. The idea, itself, however, had already been developed by American Steel Foundries and applied to the tender trucks of an order of 4-6-4-type steam locomotives built a year or more earlier and it was this company's Unit Cylinder clasp-brake design which was applied to the trucks of the Santa Fe rail car.

Mr. Dilworth's career clearly establishes the fact that keen observation and an attitude of mind, which never lets go of an experience until its significance has been appraised, backed by patient determination, and a flair for reducing problems to their simplest terms, are equally as important in the making of an engineer as formal training by way of school and college.

Books Received in Library...

Annual Review of Nuclear Science. Vol. 4, 1954. Edited by James G. Beckerley. Annual Reviews, Inc., Stanford, Calif., 1954. 483 p., $9 \times 6^1/_8$ in., bound. $7. The seventeen papers in the present volume are essentially surveys of the literature on recent developments accompanied by extensive reference lists. Three of the papers are devoted to different aspects of nuclear-particle detection, and there are papers on penetration of heavy charged particles in matter, radioactivity in geology and cosmology, and on various other topics. Author and subject indexes covering the entire volume are included.

Basic Engineering Sciences. By William Glendinning, 5123 Bell Boulevard, Bayside, New York, N. Y., 1954. 126 p., $11 \times 8^1/_2$ in., paper. $3. Problems, with solutions, selected from Part 2 of New York State Examinations for Engineer-in-Training and Professional Engineer, 1945–June, 1954. They cover various aspects of hydraulics, thermodynamics, machine design, and electrical principles and equipment, with specific problems on stream flow, heat transfer, mechanical movements, generators, and motors.

Davison's Textile Blue Book. Eighty-ninth year, 1954. Davison Publishing Co., Ridgewood, N. J., 1954. 1411 p., $8^1/_8 \times 5$ in., bound. Handy edition, $6.50. A comprehensive annual guide to the textile industry of the United States and Canada, with a section listing foreign raw-cotton firms. New mills and firms, laboratories, and manufacturers have been added since the last edition. An alphabetical index of mill dyers, finishers, etc., is provided, and the various sections are thumb-indexed for convenient use.

Library Services

Engineering Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Design of Cylindrical Shell Roofs. By J. E. Gibson and D. W. Cooper. D. Van Nostrand Company, Inc., New York, N. Y., 1954. 186 p., $9 \times 5^3/_4$ in., bound. $8.50. Though the treatment is mathematical, emphasis throughout is on the designer's concern with the use of derived equations in his calculations. The book includes a discussion of general theory, the complete design of a simple long shell, and consideration of various edge conditions—free edges, edge beams, and prestressed edge beams. There is a separate section on the use of matrices and practical questions of reinforcement are treated. The final chapter deals with general shell theory and multishells.

Development of the Guided Missile. By Kenneth W. Gatland. Philosophical Library, Inc., New York, N. Y., second edition, 1954. 292 p., $8^5/_8 \times 5^5/_8$ in., bound. $10. A survey of the evolution of guided missiles up to the present time and a description of their possible future development. Methods of propulsion of rockets and ram jets, current methods of research, and both military and peaceful applications of various types of missiles are discussed, with consideration given to rockets for high-altitude research, space satellites, and interplanetary flight. Appendixes give comparative data on 140 rockets from 8 countries and scale photographs of over 40 notable rockets.

Dynamics in Machines. By F. R. Erskine Crossley. Ronald Press Company, New York, N. Y., 1954. 463 p., $9^1/_4 \times 6^1/_4$ in., bound. $7. The subjects treated in this intermediate textbook include equations of motion, theory of vibration, rotation, effects of inertia forces in machines, balancing, and governors. Some of the illustrative problems emphasize mathematics, others are based on actual machines.

Formänderung und Profilrücknahme. Bei gerad- und schrägverzahnten Rädern. (Schriftenreihe Antriebstechnik, No. 11). By Constantin Weber and Kurt Banaschek. Friedr. Vieweg & Sohn, Braunschweig, Germany, 1953. 88 p., $11^3/_4 \times 8^1/_4$ in., paper. 13.80 DM. An analysis of deflection and profile modification of spur and helical gears. Results of theoretical and experimental investigations are given, and there are several examples showing application of the results to the calculation of addendum correction for helical gears.

Foundations of the Nonlinear Theory of Elasticity. By V. V. Novozhilov. Translated from the first Russian edition, 1948. Graylock Press, Rochester, N. Y., 1953. 233 p., $8^1/_2 \times 5^1/_2$ in., paper. $4. An exposition of the theory of elasticity without any assumptions restricting the magnitudes of elongations,

displacements, or angles of rotation, and an examination of the connection between stresses and strains in an isotropic elastic body. The theory as expounded is applied to the solution of a number of problems, including stability of elastic equilibrium; deformation of bodies having initial stresses; bending of plates and shells under deflections of the order of magnitude of the thickness; and deformation of elastic bodies which do not obey Hooke's law.

Hütte (Des Ingenieurs Taschenbuch). Vol. 2. Part A, Maschinenbau. Edited by Akademischen Verein Hütte. Wilhelm Ernst & Sohn, Berlin, Germany, twenty-eighth edition, 1954. 1292 p., $7^1/_4 \times 5$ in., bound. 25 DM. The mechanical-engineering part of this standard German handbook series has been split into two volumes owing to postwar developments. This first volume provides comprehensive and thorough coverage of machine elements, gears and gearing, machine dynamics, power economy, boiler plants, pipe lines and auxiliary devices, reciprocating machinery, turbomachinery, machine tools, and control techniques.

Hütte. (Taschenbuch für Betriebsingenieure). Volume 2. Edited by Akademischer Verein Hütte, Berlin, and Hans Rögnitz. Fourth edition, 1954, Wilhelm Ernst und Sohn, Berlin, Germany, 727 p., $8^1/_2 \times 6$ in., bound. 54 DM. This second volume of a two-volume handbook for management engineers includes the following sections: planning, construction, and equipment of manufacturing plants; service utilities; factory management and organization; mathematical and physical formulas and data including conversion tables. The index covers both volumes. All sections in this new edition have been considerably revised and enlarged.

Industrial Automatic Controls. By Millard H. LaJoy. Prentice-Hall, Inc., New York, N. Y., 1954. 278 p., $8^1/_2 \times 5^1/_4$ in., bound. $6.65. A text for a first course, requiring no mathematics beyond calculus and ordinary differential equations. Basic modes of control—two-position, proportional, floating, and rate—are analyzed, and characteristics of controller combinations are described. There are chapters covering the internal circuitry of pneumatic, hydraulic, and electronic controls, and a separate chapter surveys representative applications in the ceramic, chemical, food, power, and textile industries. The last two chapters are introductions to the theoretical analysis of industrial processes and controlled systems.

Industrial Dust. Hygiene Significance, Measurement, and Control. By Philip Drinker and Theodore Hatch. McGraw-Hill Book Company, Inc., New York, N. Y., second edition, 1954. 401 p., $9^1/_4 \times 6^1/_4$ in., bound. $10. A critical discussion, written from the engineers' standpoint, with considerable space devoted to medical aspects which influence the design and operation of dust-control equipment. It covers physical and chemical properties of dusts, fumes, and mists, and their effect on man; analysis, measurement, and microscopy of dusts; and methods for the control of dusts. Material is included on design of exhaust systems, filtering, electrical precipitation, and respirators, and there is a bibliography of 458 references.

Messung der Wärme—und Temperaturleitzahl von Metallen. By Shao-Ti Hsu and Messgerät für die Wärmeeindringzahl von Isolierstoffen. By Karl Elser. (Mitteilungen aus dem Institut für Thermodynamik und Verbrennungsmotorenbau an der E.T.H., No. 14.) Verlag Leemann, Zürich, Switzerland, 1954. 96 p., $9^1/_2 \times 6^5/_8$ in., paper. 7.30 Sw. frs. The two papers included in this contribution deal with the following topics: Measurement of the coefficient of thermal conductivity in metals by means of nonsteady heat-flow methods without the use of calorimetric measurements; description of an apparatus for measuring the coefficient of heat penetration in insulating materials with test results.

Story of Tire Beads and Tires. By Walter E. Beerton. Prepared under the sponsorship of the National-Standard Company. McGraw-Hill Book Company, Inc., New York, N. Y., 1954. 196 p., $9^1/_4 \times 6^1/_4$ in., bound. $5. In addition to detailing the history of the development of the modern bead, the book gives detailed information in relation to tire beads, on wire strength, sizes, corrosion problems, methods of testing beads and bead wire, and descriptions of bead designs and machines for making beads.

Strength of Materials. By Joseph Marin and John A. Sauer. Macmillan Company, New York, N. Y., second edition, 1954. 518 p., $9^1/_2 \times 6^1/_4$ in., bound. $6.75. This edition of a textbook for a beginning course contains new chapters on creep and temperature properties of materials and experimental methods of stress analysis. There are also new sections on vibrations of beams, stress concentration, and beam columns, and numerous changes have been made to bring the material up to date, especially in chapters dealing with fatigue and impact properties and theories of failure.

Studies in Mathematics and Mechanics. Presented to Richard von Mises by Friends, Colleagues, and Pupils. Academic Press Inc., New York, N. Y., 1954. 353 p., $9^1/_4 \times 6^1/_4$ in., bound. $9. Papers presented to the late Professor von Mises on his seventieth birthday in 1953. Included are forty-two studies, grouped about evenly under the following headings: algebra and number theory; geometry; analysis; theoretical mechanics; applied mechanics; and probability and statistics. The papers are in English except for a few in French and Italian and one in German. A list of von Mises' writings is included.

Synthetic Rubber. Prepared under the auspices of the Division of Rubber Chemistry, American Chemical Society. G. S. Whitby, editor-in-chief. John Wiley & Sons, Inc., New York, N. Y., 1954. 1044 p., $9^1/_4 \times 6^1/_4$ in., bound. $8. Thirty-eight specialists have contributed to this exhaustive review of research and development in the science and technology of the subject, which covers in detail various phases of the chemistry and physical chemistry, manufacture of raw materials, conversion processes, and the use of the material in industry. There is a separate chapter on German developments. Extensive chapter bibliographies, a name index, and a subject index are included.

Table of Sine and Cosine Integrals for Arguments From 10 to 100. (Applied Mathematics Series, No. 32) National Bureau of Standards. Superintendent of Documents, G.P.O., Washington 25, D. C., 1954. 187 p., $10^1/_2 \times 8$ in., bound. $2.25. The values of the sine and cosine integrals are tabulated to ten decimal places for the range of χ between ten and 100, at intervals of 0.01. This is a reissue of the table with the same title, prepared by the WPA Mathematical Tables Project, with some changes in the auxiliary tables. The customary bibliography and explanatory introduction are included.

Table of the Gamma Function for Complex Arguments. (Applied Mathematics Series, No. 34). National Bureau of Standards. Available from Superintendent of Documents, G.P.O., Washington 25, D. C., 1954. 105 p., $10^1/_2 \times 8$ in., bound. $2. This table gives $\log_e \Gamma(\chi + iy)$ to 12 decimals for values of χ and y, from 0 to 10, at intervals of 0.1, and from the table the values of $\Gamma(Z)$ in the corresponding squares of three other quadrants can be obtained. The volume also includes an explanatory introduction and a bibliography of related tables and general references.

Treatise on Applied Hydraulics. By Herbert Addison. John Wiley & Sons, Inc., New York, N. Y., fourth edition, 1954. 724 p., $8^3/_4 \times 5^1/_2$ in., bound. $9.50. The present edition of this work, which originally appeared in 1934, limits itself, like its predecessors, to direct explanations of hydraulic principles and provides bibliographies of selected references for those needing more detailed information. Fundamentals are treated in the first section of the book and applications in pipes and piping systems, hydraulic turbines, pumping machinery, etc., in the second section. The new edition has been thoroughly revised with the addition of about a hundred pages of text.

Utilization of Heat Resistant Alloys. American Society for Metals, Cleveland, Ohio, 1954. 288 p., $9^1/_4 \times 6$ in., bound. $6. Contains eleven papers presented at a symposium in honor of Albert E. White and a chronological list of his writings. The papers, prepared by metallurgists and engineers, deal with a variety of topics: creep and fracture, stress calculations for design for creep conditions, production and fabrication, and materials for jet engines, aircraft gas turbines, central-station piping, and other purposes.

Die Wälzlagerpraxis. By Eschmann, Hasbargen, and Weigand. Verlag Von R. Oldenbourg, Munich, 1953. 372 p., $9^1/_2 \times 7$ in., bound. 32 DM. A comprehensive manual on the calculation and design of ball and rolling bearings. The several sections cover the following: types, materials, dimensions, and tolerances of modern European antifriction bearings; theoretical design; construction fundamentals; design of bearing locations; defects, their causes, and effects; typical examples of applications.

Welding of Plastics. By G. Haim and H. P. Zade. Manual for Plastic Welding—Polyethylene. By G. Haim and J. A. Neumann. (Welding of Plastic Series, Volumes 1 and 2, 1947, London, England, 1954). Available from The Industrial Book Company, 1240 Ontario Street, Cleveland, Ohio. 206 p., 128 p., $8^3/_4 \times 5^3/_4$ in., bound. Each volume $6. The first of these volumes in the "Welding of Plastics Series" covers general aspects: chemistry and physics of weldable plastics and their technology; hot gas, heated-tool, high-frequency and other welding processes; seam-welding machines; and industrial applications in the chemical industry, in packaging, etc. Volume two is a discussion of welding of polyethylene and its applications with separate chapters devoted to tank linings and pipe lines.

ASME NEWS

With Notes on the Engineering Profession

ASME Diamond Jubilee Semi-Annual Meeting Plans Theme: The Engineer and the World of Science

Hotel Statler, Boston, Mass., Headquarters. Plans include 45 technical sessions and inspection trips. Leading engineers to be honored

The theme "The Engineer and the World of Science" marks the program of the ASME Diamond Jubilee Semi-Annual Meeting to be held June 19–23, at the Hotel Statler in Boston, Mass.

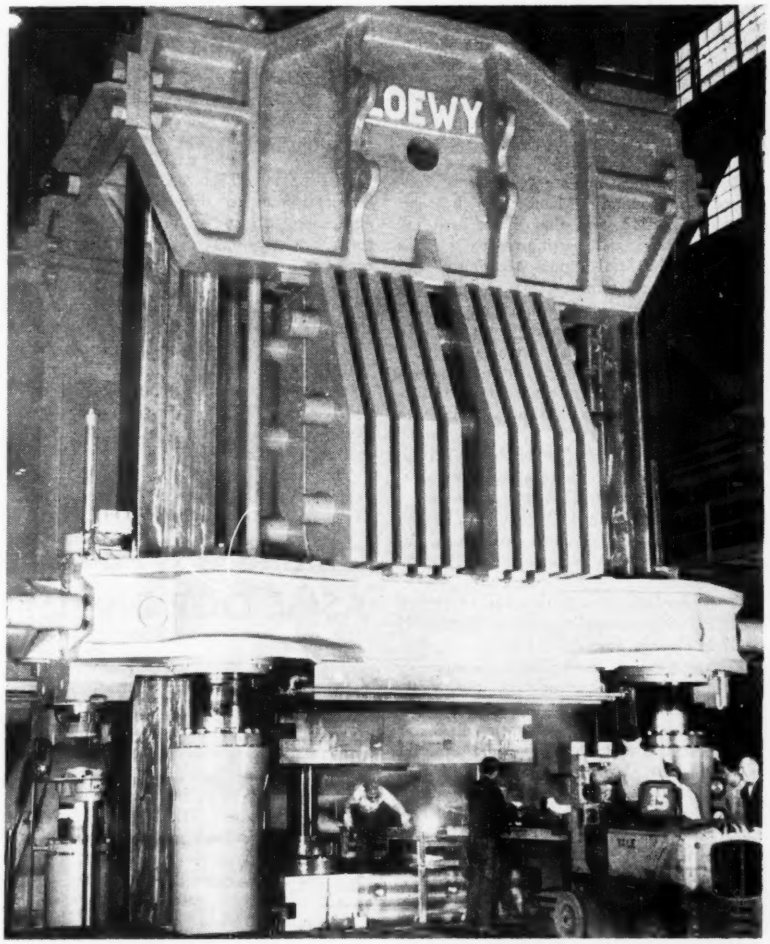
This meeting is the fourth of five national meetings scheduled to celebrate the Society's Jubilee Year.

Historic Boston is the ideal place for the Society to hold a commemorative meeting. The time of year weatherwise is right also. New England is just coming into its famed season as vacation land. The narrow crooked streets of Boston, although most annoying to one trying to keep a schedule, are full of historical interest at every bend. This is the city of Faneuil Hall, "The Cradle of Liberty"; of Paul Revere, where his house and shop still stand; Old North Church whose tower was blown down by last August's hurricane; of Bunker Hill; and Rowe's Wharf. Many other places of special interest to Americans, too numerous to list, are to be seen here. Recently restored is the first iron works in the country in the suburb of Saugus. Boston always has been wedded to the sea. Visits to the historic fish pier with its rusty trawlers, drying nets, and its fascinating odors—just bad enough to be enticing—is an experience for either engineer or artist.

To come to Boston for a meeting entitled The Engineer and the World of Science is proper. Here is the famous "research row" along the Charles River basin; the great and famous educational institutions; the expanding research establishments recently joined by the Air Force Research Laboratories and the Quartermaster Corps Laboratories, and numerous smaller organizations.

Technical Sessions

The program is still in the process of completion; however, from all indications there will be a wealth of interesting material and meetings from which to choose. The 75th Anniversary Panel will be held on Tuesday afternoon and Wednesday morning, June 21 and 22. The banquet will be held on Tuesday evening.



Giant hydraulic closed-die forging press is shown as it went into customer production recently at Wyman-Gordon Company-USAF plant in North Grafton, Mass. This plant is to be visited during the ASME Diamond Jubilee Semi-Annual Meeting, to be held in Boston, Mass., June 19–23. The press exerts a 35,000-ton pressure and is the largest of its kind in use.

There will be six periods available for some 45 technical sessions and at the present time the following Professional Divisions' sessions will be included: Applied Mechanics, Aviation, Fuels, Gas-Turbine Power, Heat Transfer, continuing the ASME-IME International Conference on Combustion Meeting at Massachusetts Institute of Technology June 15–17 (see pages 370–371 of this issue for program), Hydraulics, Machine Design, Management, Materials Handling, Metals Engineering, Power, Process Industries, Production Engineering, Rubber and Plastics, Safety, Textile Engineering, Education, National Junior Committee, Fluid Meters, and Metal Processing.

Plant Trips

There are three interesting plant trips being developed. Of primary interest is a visit to the first superheavy press at the Wyman-Gordon plant in North Grafton. This has been scheduled for Friday, June 24, so that as many as possible can attend. A trip to the new Climatic Laboratory of the Army Quartermaster Corps in Natick has been arranged for Tuesday morning. On Thursday afternoon a trip has been scheduled to the General Electric River Works at Lynn.

Honor Eminent Engineers

The following eminent engineers were elected to Honorary Membership by the Council of ASME, and they have been invited to attend and participate in the activities of the Semi-Annual Meeting:

Jacob Ackeret, professor of aerodynamics, Federal Institute of Technology, Zurich, Switzerland, is an outstanding Swiss aerodynamicist and mechanical engineer and specialist in linear supersonic theory. He directed and carried out widespread research on lifting surfaces, compressors, gas turbines, and other fluid machinery.

Hilding Valdemar Tornebohm, Fellow ASME, is president, International Organization for Standardization, leader in international standardization affairs, and vice-president in charge of Technical Directorate Bureau, Aktiebolaget Svenska Kullagerfabriken, Gothenburg, Sweden.

Ernest Frederic Mercier is a retired French engineer; with outstanding accomplishments in fields of electric power, mechanical and electrical engineering, management, finance and international relations—one of the really great men of France.

Sir Vincent de Ferranti is chairman, World Power Conference (ASME is member body of U. S. National Committee, WPC); past-president, The Institution of Electrical Engineers; and chairman and managing director of Ferranti, Ltd.

Richard E. Heartz, Mem. ASME, is president, Engineering Institute of Canada; president and director, Shawinigan Engineering Company, Ltd., Montreal, Que., Can.; and outstanding engineer especially in the field of power development and shipbuilding.

Percy L. Jones, president of The Institution of Mechanical Engineers (London). He will attend ASME-IME Combustion Conference in Cambridge, Mass., June 15–17, 1955. Honorary Membership will be conferred on him at that meeting.

ASME Mid-Hudson Section receives its charter, Jan. 20, 1955, at the Nelson House, Poughkeepsie, N. Y. Participating in the ceremonies, which were attended by 128 persons, are shown, *left to right*, J. L. O'Neill, Chairman, Mid-Hudson Section, ASME; W. H. Byrne, Vice-President, Region II, ASME; and H. R. Kessler, past Vice-President, Region II, ASME. Representatives from the leading local industries also attended.

Entertainment

An excellent entertainment program is being set up with the help of the Ladies' Committee. Beginning with a tea on Sunday afternoon, June 19, there is an attractive program in a center of our country rich in historical and literary interest.

An opportunity has been provided for ASME members and their guests to attend a concert by the Boston "Pops" Orchestra at Symphony Hall on Monday evening, June 20. The usual program of popular and semiclassical music will be played by this internationally famous group composed of members of the Boston Symphony Orchestra.

The ASME Group will occupy seats at tables on the floor; at which light refreshments will be served during the concert. Each table will accommodate five persons. Reservations may be made for single seats or for entire tables.

On Tuesday, before the banquet, there will be a Boston Section-sponsored social hour and after the banquet a dance is being arranged. Wednesday is a free evening for members and their families to visit the city and some of its historic monuments. On Thursday evening there are plans under way for a famous New England clambake.

Women's Program

A women's program is well along the way. So far it includes, in addition to the general program, a visit to the beautiful Gardner Museum. Sight-seeing trips to historical Lexington and Concord and cruises in the harbor are under consideration.

Oil and Gas Power for National Defense—ASME OGP Division Conference Theme

OGP 27th Annual Conference, Hotel Statler, Washington, D. C., June 6–9

The Oil and Gas Power Division of The American Society of Mechanical Engineers 27th Annual Conference and Exhibit is scheduled for June 6 to 9, inclusive, at the Hotel Statler, Washington, D. C. The generous cooperation of the Military Services, not only in making local arrangements but in active participation in the technical program, and the locale naturally suggested the theme of this conference—"Oil and Gas Power for National Defense."

Technical Sessions

Prominent military and marine authorities will draw on their diesel experience both in technical papers and panel discussions. Also listed on the technical program are leading civilian authorities in this field.

Highlighting the technical sessions will be C. G. A. Rosen's paper on Diesel Engine Developments—a combined history and forecast of the diesel engine. Mr. Rosen, Fellow ASME, is widely known as engineering consultant to the president of Caterpillar Tractor Company and is 1955 president of the Society of Automotive Engineers.

Advance bookings promise that this is to be the most extensive and diversified group of exhibits yet seen at an OGP conference.

The Washington Section of the Society, host to the Conference, is taking full advantage

of local attractions to prepare an interesting and pleasurable program for the members and their guests. A special program is being prepared for the women. Social events for the entire group are also being arranged.

Tentative Program

The tentative program follows:

MONDAY, JUNE 6

Morning, Technical Session 1

Submarine-Engine Development, by *Anker Antonson,* Fairbanks Morse Co.

Afternoon, Technical Session 2

Gas Turbines for Ship Propulsion, by *John McMullen,* U. S. Maritime Commission

The Philosophy of Vee-Engine Design, by *Ralph Boyer,* Cooper-Bessemer Corp.

Evening: Meeting of the General Technical Committee to which all registrants at the conference are welcome

Subject: **Specifications**

TUESDAY, JUNE 7

Morning, Panel 1

Heavy Fuels for Gas Turbines, by *Harry King* and *Harold Nut,* U. S. Navy

Moderator: *Captain Latrobe,* U. S. Navy

Afternoon, Panel 2

Standardization of Diesel Engines, by *Captain C. A. Peterson* and *Lieut. Comdr. Wilford Howerton,* U. S. Navy

Moderator: *Captain William Dolan,* U. S. Navy

Evening

Annual Banquet

WEDNESDAY, JUNE 8

Morning, Technical Session 3

Diesel-Engine Developments, by *C. G. A. Rosen,* Caterpillar Tractor Co.

High-Pressure Turbocharging, by *Rudolph Birmna,* DeLaval Steam Turbine Co.

Afternoon, Technical Session 4

Fatigue Characteristics of New and Used Crankshafts, by *Joseph L. Aringtone,* U. S. Navy

Analysis of Noise Sources in the Diesel Engine, by *Kenneth R. Mercy,* U. S. Navy

THURSDAY, JUNE 9

Morning, Technical Session 5

Heavy-Fuel Filtration, by *Fred Smith,* Sharples Corp.

Cetane Improver for Heavy Fuels, by *W. H. Hubner,* Ethyl Corp.

Afternoon, Technical Session 6

Effect of Size on the Inlet-System Dynamics, by *D. H. Tsai,* National Bureau of Standards

Marine Application of the Supairthermal Engine, by *Hans Leberherr* and *Ralph H. Miller,* Nordberg Manufacturing Co.

First ASME IRD Conference in Ann Arbor, April 25-26

The first Instruments and Regulators Division Conference of The American Society of Mechanical Engineers will be held at the University of Michigan, Ann Arbor, Mich., on April 25 and 26, 1955.

There will be four sessions with two papers for each session. The program includes two formal luncheons; one on Monday with G. G. Brown, dean of the college of engineering of the University as the speaker, and a luncheon on Tuesday with A. C. Pasini, Director, ASME, of the Detroit Edison Company in Detroit, Mich.

The conference banquet will be held on Monday evening with U. E. Arnold as the principal speaker. Professor Arnold is a member of the Massachusetts Institute of Technology faculty in Cambridge.

There will be a special women's program on both days, with luncheons and interesting events.

Some of the papers to be presented at the conference are: Improving Airplane-Handling Characteristics With Automatic Controls, by Clifford L. Muzzey; Disturbance-Response Feedback—A New Control Concept, by James B. Reswick; Determination of System Characteristics From Normal Operating Records, by Thomas P. Goodman and James B. Reswick; Improved Process Control From Noninteracting Controller Design, by D. P. Waite; A Study of Pneumatic Processes in Continuous Control of Motion, by J. Lowen Shearer; and Dynamic Analysis of Chemical Processes, by E. G. Holzmann.

ASME-IME International Conference on Combustion to Be Held June 15–17

The ASME-IME International Conference on Combustion is scheduled to be held June 15–17, 1955, at Massachusetts Institute of Technology, Cambridge, Mass. The Conference will be sponsored by The American Society of Mechanical Engineers and The Institution of Mechanical Engineers (London) in co-operation with Massachusetts Institute of Technology.

The tentative program follows:

TUESDAY, JUNE 14

3:00 p.m.–5:00 p.m.

Registration

WEDNESDAY, JUNE 15

8:00 a.m.–5:00 p.m.

Registration

9:00 a.m.

Session 1—Opening Session

American Papers

Methods of Approach in Combustion Research, by *Ralph Sherman* and *William T. Reid*

Application of Scientific Principles to Combustion Practice, by *Bernard Lewis*

British Paper

Chemistry and Physics of Combustion, by *Sir Alfred Egerton, O. A. Saunders,* and *D. B. Spalding*

12:15 p.m.

Informal Luncheon

2:00 p.m.

Session 2—Boilers

American Papers

Instruments as Applied to Flame Failure, by *W. D. Stevens*

Some Methods for Disposal and Elimination of Petroleum-Refinery Waste Gases and Fumes, by *O. F. Campbell*

Effect of Fuel Properties on Firing Methods, by *Lewis R. Burdick* and *Richard C. Corey*

Furnaces for Low-Quality Solid Fuels, *by Otto de Lorenzi*

British Papers

Boiler Availability—A Commentary, by *H. E. Crossley* and *W. G. Marskell*

Liquid-Fuel Firing, by *R. P. Fraser* and *W. A. Hubbard*

Combustion of Pulverized Fuel, by *W. F. Simonson*

Spreader Stokers and Combustion, by *N. Platt*

The Development and Practice of Cyclone Firing in Germany, by *H. Seidl*

6:30 p.m.

Entertainment

THURSDAY, JUNE 16

8:00 a.m.–5:00 p.m.

Registration

9:00 a.m.

Session 3—Industrial Furnaces

American Papers

Gas as a Source of Protective Atmosphere in Industrial Furnaces, by *E. J. Funk, Jr.*

The Status of Combustion in Industrial Furnaces, by *J. J. Turin* and *J. Huebler*

Instruments as Applied to Product Improvement in Steel Furnaces, by *J. W. Percy*

Instrumentation of Process Tubular Heaters, by *L. A. Mekler*

High-Temperature Gas Jets as Applied to Some Manufacturing Processes, by *James B. Henwood*

British Papers

Calculated and Measured Performance of an Open-Hearth Furnace, by *J. H. Chesters, M. W. Thring,* and *S. W. Pearson*

Design of Burners for Open-Hearth Furnaces, by *M. P. Newby, G. R. Mattocks,* and *M. J. McInerny*

Combustion and Thermal Transfer in Continuous-Reheating Furnaces, by *H. Southern, D. Smith,* and *F. A. Gray*

Combustion and Heat Transfer in Glass Tanks, by *J. Richardson* and *S. Krusewski*

Advance in Cupola Combustion, by *G. A. H. Jungbluth* and *K. Roesch*

12:15 p.m.

Informal Luncheon

2:00 p.m.

Session 4—Internal-Combustion Engines

American Papers

High-Compression Turbocharged Spark-Ignition Gas Engines, by *W. M. Kauffmann*

Heat-Release Rates in Hydrocarbon Combustion, by *John P. Longwell* and *Malcolm A. Weiss*

Surface Ignition in a Motored Engine, by *J. C. Livengood, T. Y. Toong, T. P. Rona, C. F. Taylor,* and *I. A. Black*

British Papers

Combustion in Large Diesel Engines, by *P. Jackson*

Combustion Products and Wear in High-Speed Compression-Ignition Engines With Particular Reference to the Use of Lower-Grade Fuels, by *W. T. Lyn*

Combustion in Petrol Engines, by *R. Vichnievsky*

Combustion in Dual-Fuel Engines, by *N. P. W. Moore*

6:30 p.m.

Banquet

Toastmaster: *R. J. S. Pigott,* past-president ASME

Speaker: *E. G. Bailey,* past-president ASME and Honorary Member IME

Remarks by presidents of IME and ASME

Presentation of Honors

FRIDAY, JUNE 17

8:00 a.m.–2:00 p.m.

Registration

9:00 a.m.

Session 5—Gas Turbines

American Papers

Application of Electronic Probes to Measurements in Turbulent Flames, by *Béla Karlovitz*

Iridium Versus Iridium-Rhodium Thermocouples for Gas-Temperature Measurements Up to 3500 F, by *C. R. Droms* and *A. I. Dahl*

Coal-Firing for the Open-Cycle Gas Turbine—A Comparison of Methods, by *Herbert R. Hazard*

Combustion of Blast-Furnace Gas in Gas Turbines, by *A. E. Hershey*

British Papers

The Relation of Specific Heat Release to Pressure Drop in Aero-Gas-Turbine Combustion, by *J. S. Clarke*

Combustion Chambers and the Control of Temperature at Which They Operate, by *W. Tipler*

The Use of Solid Fuels in Gas Turbines, by *T. F. Hurley* and *W. V. Battock*

Combustion of Residual Fuel in Gas Turbines by *P. T. Sulzer* and *I. G. Bowen*

Operating Experience With Combustion Equipment in Industrial Gas Turbines, by *C. Kind*

Application of Research to Gas-Turbine Combustion Problems, by *R. P. Probert*

12:15 p.m.

Informal Luncheon

2:00 p.m.

Session 6—General Discussion

During this period, there will be four simultaneous sessions to provide a forum for any specialized discussion arising from Sessions 2, 3, 4, or 5.

ASME Region VIII Engineering Conference Plans Announced

The Region VIII Engineering Conference, sponsored by the South Texas Section of The American Society of Mechanical Engineers, will be held at the Rice Hotel, Houston, Texas, April 24–27.

The program has been designed to provide technical sessions covering low-pressure vessels and equipment, steam-power plants, processing plants, and other operations of interest to mechanical engineers. A forum is scheduled for discussion of codes and standards, with special emphasis on the Code for Pressure Piping, ASA B-31.1. Plans also have been made for the ASME student branches of Region VIII, which area includes Texas, Louisiana, Oklahoma, Kansas, Colorado, Wyoming, New Mexico, and Mexico, to participate.

Technical Sessions

The technical sessions are to be presented in four groups, namely, nuclear energy, stress analysis, pressure-vessel design and metallurgy, and codes and standards.

The symposium on pressure piping will include a panel composed of members of the subcommittees on oil-refinery piping, oil-transportation pipe lines, and gas-transmission and distribution-piping systems.

Social Events

On Monday, April 25, David W. R. Morgan, ASME President, will be principal speaker at the Welcoming Luncheon. There will be an honors and awards banquet during the meeting, at which time members and student members of the South Texas Section will receive ASME awards earned during the past year.

NSF Supports Travel

The National Science Foundation will consider applications for the support of travel to assist a limited number of American engineers to attend the sixth plenary meeting of the International Association for Hydraulic Research, to be held from Aug. 29 to Sept. 2, 1955, at Delft, The Netherlands.

Application forms may be obtained by writing to the Division of Mathematical, Physical, and Engineering Sciences, National Science Foundation, Washington 25, D. C. Applications must be received by May 1, 1955, in order to be considered.

1955 ASME National Applied Mechanics Conference June 16–18 Program Announced

Headquarters: Rensselaer Polytechnic Institute, Troy, N. Y.

The Applied Mechanics Division of The American Society of Mechanical Engineers announced that the 1955 National Applied Mechanics Conference will be held June 16–18, at Rensselaer Polytechnic Institute, Troy, N. Y., with the following tentative program:

THURSDAY, JUNE 16

Morning Session

Chairman: *Dana Young*, Yale University

Influence of Secondary-Inertia Terms on Natural Frequencies of Rotating Beams, by *John L. Bogdanoff*, Purdue University

Nonlinear Dynamic Coupling in a Beam Vibration, by *P. H. McDonald, Jr.*, North Carolina State College

Some Solutions of the Timoshenko Beam Equations, by *Bruno A. Boley*, Columbia University, and *Chi-Chang Chao*, Columbia University

Complex Variable Method for Synthesis of Four-Bar Linkages,[1] by *N. Rosenauer*, New South Wales University of Technology, Sydney, N.S.W., Australia (Paper No. 55—APM-7)

Afternoon Session

Chairman: *B. Budiansky*, National Advisory Committee for Aeronautics

An Approximate Nonuniform Bending Theory and Its Application to the Swept-Plate Problem, by *H. J. Plass, Jr.*, University of Texas (Paper No. 55—APM-6)

Forced Vibration of a Clamped Rectangular Plate in Fluid Media, by *Gordon C. K. Yeh*, Reed Research, Inc., Washington, D. C., and *Johann Martinek*, Reed Research, Inc.

On the Nonlinear Oscillations of Viscoelastic Plates, by *A. C. Eringen*, Purdue University

The Extended Theory of the Viscous Vibration Damper, by *Frank M. Lewis*, Massachusetts Institute of Technology (Paper No. 55—APM-3)

[1] Presented by title only.

FRIDAY, JUNE 17

Morning Session

Chairman: *Lloyd H. Donnell*, Illinois Institute of Technology

Buckling of Laminated Columns, by *Lyle G. Clark*, University of Michigan

Free Vibrations of Thin Cylindrical Shells Having Finite Lengths With Freely Supported and Clamped Edges, by *Yi-Yuan Yu*, Syracuse University

Thin Circular Conical Shells Under Abitrary Loads, by *N. J. Hoff*, Polytechnic Institute of Brooklyn

Simplified Formulas for Boundary-Value Problems of the Thin-Walled Circular Cylinder,[1] by *Frederick V. Pohle*, Polytechnic Institute of Brooklyn, and *S. V. Nardo*, Polytechnic Institute of Brooklyn (Paper No. 55—APM-9)

Afternoon Session

Chairman: *Lawrence E. Goodman*, University of Minnesota

Stress Distribution in Square Plates With Hydrostatically Loaded Central Circular Holes, by *A. J. Durelli*, Armour Research Foundation, and *J. B. Barriage*, Armour Research Foundation (Paper No. 55—APM-12)

Thermal Stresses in Rectangular Strips II, by *Gabriel Horvay*, Knolls Atomic Power Laboratory, General Electric Company, and *J. S. Born*, Knolls Atomic Power Laboratory, General Electric Company (Paper No. 55—APM-4)

Force at a Point in the Interior of a Semiinfinite Solid With Fixed Boundary, by *Leif Rongved*, Pennsylvania State University (Paper No. 55—APM-14)

Forced Vibrations of a Body on an Infinite Elastic Solid, by *R. N. Arnold*, University of Edinburgh, Edinburgh, Scotland, *G. N. Bycroft*, National Research Scholar of the Department of Scientific and Industrial Research, Wellington, New Zealand, and *G. B. Warburton*, University of Edinburgh, Edinburgh, Scotland

[1] Presented by title only.

SATURDAY, JUNE 18

Morning Session

Chairman: *R. E. Peterson*, Westinghouse Research Laboratories

Experiments Concerning the Yield Surface and the Assumption of Linearity in the Plastic Stress-Strain Relations,[1] by *Paul M. Naghdi*, University of Michigan, *C. W. Beadie*, University of Michigan, and *J. C. Rowley*, University of Michigan (Paper No. 55—APM-5)

Combined Tension-Torsion Tests With Fixed Principal Directions, by *Evan A. Davis*, Westinghouse Research Laboratories

The Statistical Theory of Size and Shape Effects in Fatigue, by *Frank A. McClintock*, Massachusetts Institute of Technology

A Criterion for Minimum Scatter in Fatigue Testing, by *Frank A. McClintock*, Massachusetts Institute of Technology

Morning Session

Chairman: *H. W. Emmons*, Harvard University

A Study of the Stability of Plane Fluid Sheets, by *W. W. Hagerty*, and *J. F. Shea*, both of University of Michigan

Integral Methods in Natural Convection Flow, by *Salomon Levy*, General Electric Company

Aerodynamic Interference of Cascade Blades in Synchronized Oscillation, by *Chieh-Chien Chang*, University of Minnesota, and *Wen-Hua Chu*, University of Maryland

On the Kinematic Path of Semi-Trailers,[1] by *Gabriel A. G. Fazekas*, Polytechnic Institute of Brooklyn

Afternoon Session

Chairman: *Daniel C. Drucker*, Brown University

The Permanent Deflection of a Plastic Plate Under Blast Loading, by *Alexander J. Wang*, Illinois Institute of Technology (Paper No. 55—APM-1)

Limits of Economy of Material in Plates, by *William Prager*, and *H. G. Hopkins*, both of Brown University (Paper No. 55—APM-2)

Large Plastic Deformations of Circular Membranes, by *N. A. Weil*, The M. W. Kellogg Company, and *N. M. Newmark*, University of Illinois

Torsion of Circular Shafts of Variable Diameter,[1] by *Mohammed M. Abbassi*, Alexandria University, Alexandria, Egypt

[1] Presented by title only.

Founding Anniversary Meeting Launches ASME Diamond Jubilee Celebration

• Many Communications Media Send Greetings
• Engineer and His Communications Discussed

THE Founding Anniversary Meeting of The American Society of Mechanical Engineers, the first in a series of five scheduled this year to commemorate the Society's 75 years of service in the field of mechanical engineering, was held in New York, N. Y., on Feb. 16, 1955. Theme of this meeting was "The Engineer and the World of Communications."

The day-long program opened with a special Commemorative Session in the auditorium of the McGraw-Hill Publishing Company. In the afternoon a panel of four experts delved into the problem of The Engineer and the World of Communications at a General Session in the auditorium of the Engineering Societies Building. A dinner meeting at the Waldorf-Astoria Hotel, with Dr. Vannevar Bush, president of the Carnegie Institute of Washington, as principal speaker, climaxed the day's events.

Commemorative Session

At the commemorative ceremonies at McGraw-Hill 19 leading institutions in the various communications media and fields paid their respects to ASME.

Formal greetings were presented by the National Conference of Business Paper Editors; American Society of Newspaper Editors; National Association of Science Writers; Aviation Writers Association; New York Financial Writers Association; Society of Business Magazine Editors; Newspaper Reporters Association of New York City, Inc.; Theta Sigma Phi; American College Public Relations Association; Public Relations Society of America; The Associated Business Publications; Magazine Publishers Association, Inc.; National Association of Radio and Television Broadcasters; American Book Publishers Council, Inc.; American Textbook Publishers Institute; Advertising Federation of America; American Association of Advertising Agencies; National Industrial Advertisers Association; and The Advertising Council, Inc.

The groups were represented by L. N. Rowley, Jr., editor of *Power*, speaking for the journalism field; Harold E. Fellows, president and chairman of the board, National Association of Radio and Television Broadcasters, speaking for the broadcasting field; James W. Armsey, assistant to the Chancellor, New York University, speaking for the public-relations field; Albert Hauptli, Jr., publisher of *American Machinist*, speaking for the periodicals group; Charles G. Bolte, executive secretary of the American Book Publishers Council, Inc., speaking for the book publishers; and Elton G. Borton, president and general manager, Advertising Federation of America, speaking for the advertising field.

Burnham Finney, editor of *American Machinist* and general chairman of ASME Founding Anniversary-Day Program, presiding at morning session at McGraw-Hill auditorium.

President Morgan Responds

David W. R. Morgan, President of ASME and vice-president of Westinghouse Electric Corporation, in acknowledging the greetings, said that the McGraw-Hill Auditorium was an appropriate place for the Society to initiate its 75th anniversary observance. He pointed out that it was in the office of the *American Machinist*, now a McGraw-Hill publication, that ASME was founded by a group of distinguished mechanical engineers on Feb. 16, 1880.

ASME, Mr. Morgan said, has for 75 years been one of the most important American engineering groups exercising the group effort and group foresight that are essential to America's enduring strength. Group effort has been basic to our living standards—living standards the people of other nations have learned to desire for themselves as the right of all free men, he said. It has been basic to the productive strength that has preserved the right of people to enjoy or strive for human freedom. Engineering group effort and foresight are basic today to the attainment and preservation of the standards under which we want our children to live tomorrow. In serving its members individually, ASME has always remembered to serve truth, and to render public service for the enrichment of mankind.

In celebration of the Seventy-Fifth Anniversary of the Society, Mr. Morgan declared, we rededicate ASME—By Truth and by Service to Enrich Mankind.

The Society has helped signally in building the engineering strength whose absence in so much of the world leaves poverty-striken, restless people where abundance has long been possible. It is a solid foundation block beneath our technological-industrial structure.

Today, Mr. Morgan pointed out, ASME looks forward to even greater usefulness by continuing to meet, by voluntary association within itself and with others, the problem of the atomic age now upon us.

Plaque Presented

On behalf of the members of ASME Mr. Morgan then presented a plaque—Commemorating the Founding Meeting of The American Society of Mechanical Engineers in the offices of the *American Machinist*, February 16, 1880—to Donald McGraw, president of McGraw-Hill and host of the morning session, and Albert Hauptli, Jr., publisher of the *American Machinist*.

Tribute to Harvey F. Mack

Mr. Morgan also paid tribute to Harvey F. Mack, the Society's present printer, who in the depths of a depression in the 1930's, exercised consideration and patience when ASME was short of funds and thus permitted the Society to remain in communication with its members and to publish papers presented at meetings.

Burnham Finney, editor of the *American Machinist*, presided.

Engineering Societies Library Visited

Following the morning session, many of the guests availed themselves of the opportunity of visiting the Engineering Societies Library. Ralph H. Phelps, director of the Library, conducted the tour which included an inspection of the reading room, stacks, and adjunct facilities.

ASME President D. W. R. Morgan, *right,* presents plaque to Albert Hauptli, *left,* and Donald C. McGraw, *center.* The plaque commemorates the Founding Meeting of ASME in the offices of the *American Machinist* on Feb. 16, 1880.

Panel members getting ready to delve into the subject, The Engineer and the World of Communications, are, *left* to *right:* Edgar Kobak, James G. Lyne, Willard T. Chevalier, chairman, Ormand J. Drake, and E. W. Engstrom. General session took place in Engineering Societies Building auditorium.

Shown, *left* to *right*, at the banquet at the Waldorf-Astoria Hotel are: Vannevar Bush, William L. Batt, and Howard S. Bean. Dr. Bush, the principal speaker, also received Honorary Membership in ASME at the dinner. Mr. Batt was toastmaster. Mr. Bean was awarded the 1955 Worcester Reed Warner Medal.

Communications Panel

In the afternoon session at the Engineering Societies Building four specialists covered various aspects of the engineer and his communications.

The speakers were Edgar Kobak, president of the Advertising Research Foundation, New York; James G. Lyne, president of Simmons-Boardman Publishing Company, New York; Ormand J. Drake, assistant secretary of New York University; and E. W. Engstrom, executive vice-president for research and engineering of Radio Corporation of America.

Chairman of the session was Willard T. Chevalier, executive vice-president of McGraw-Hill Publishing Company.

Colonel Chevalier set the tone of the proceedings by stating that "the whole question of world peace and world security today is becoming a problem of communications. Too much of today's communications, however, consist of words, and not of ideas."

Mr. Kobak, who is a former president of the Mutual Broadcasting Company and has also worked in the advertising and technical publishing fields, decried the poor publicity sense of engineers, as opposed to that of such groups as medical men and scientists. He urged his audience not to sacrifice the practice of engineering in favor of promotion or publicity, but to do a better job of making themselves and their works known.

Mr. Lyne warned that "the very magnitude and variety of avenues of communications have resulted in a bedlam of sound, of print, and of visual images—with the result that the communicator can no longer rely on the intrinsic merit of his message alone to win an audience for what he has to say."

Mr. Drake, who was formerly chairman of the department of speech at N.Y.U., covered the subject of spoken communications. He discussed the three elements that go into a speech—speaker, subject matter, and audience—and said that the last is the most important of the three.

Dr. Engstrom outlined the prospects for the communications of the future. Chief areas of development in "the early portion of the next 74 years," he said, will lie in the fields of solid-state devices, including replacement of the modern television tube by a thin screen hung in a picture frame on the wall and controlled from a small box elsewhere in the room; advances in personal communications, making possible instantaneous contact between people at any distance; more efficient use of communication channels, especially in regard to machines and systems that will respond to the spoken word and, conversely, reproduction of process data in spoken form, as with the recently announced RCA music synthesizer; and data-handling machines for business and industry.

Vannevar Bush—Banquet Speaker

As principal speaker at the banquet in the Waldorf-Astoria Hotel, Vannevar Bush called on the federal government to undertake planning for a giant project to code the mounting volume of human knowledge and make it available "in prompt, accurate, effective fashion, and at a distance, if this is desired."

L. N. Rowley, Jr., speaking for the journalism field

A. Hauptli, Jr., representing the periodical publishers

H. E. Fellows, for the radio and television broadcasters

Greetings presented to ASME on its Seventy-Fifth Anniversary from Associations and Societies representing the various communications media and fields

J. W. Armsey, representing the field of public relations

E. G. Borton, speaking for the field of advertising

Dr. Bush described equipment now available that can scan items at the rate of one thousand a second; photographic methods that make it possible to cram the material of a thousand books into the space of a cigarette package; and digital computing devices that can manipulate records in the form of numbers at the rate of one million operations a second. He spoke on "Communications—Where Do We Go From Here?" For the text of Dr. Bush's address see pages 302 to 304 of this issue.

Engineering Societies Library Welcomes Members' Visits

Members and others attending Society meetings or just visiting in New York, N. Y., are invited to visit the Engineering Societies Library in the Headquarters building at 29 West 39th Street, New York, N. Y.

The Engineering Societies Library has an outstanding collection of mechanical-engineering literature. Its 170,000 volumes also cover all fields of engineering, primarily on the level of the graduate and practicing engineer. Student Members find the Engineering Societies Library collection useful as it supplements those of the engineering schools.

The reading room of the Library is open Mondays through Fridays, 10:00 a.m. to 9:00 p.m. and Saturdays 10:00 a.m. to 6:00 p.m. A visit to the Library has a twofold advantage: Inspection of the collection and information on how the Library can serve by mail, telephone, or telegraph, as well as in person.

Honors and Awards

A feature of the dinner program was the conferring of honors and awards.

The 1955 Worcester Reed Warner Medal was awarded to Howard S. Bean, Fellow ASME, for his valuable contributions to the art and science of fluid metering and his unselfish work in preparing the many authoritative publications on this subject, particularly the widely used reports of the ASME Fluid Meters Research Committee.

Mr. Bean is chief of the Capacity Density, and Fluid Meters Section of the National Bureau of Standards.

Honorary Membership in ASME was conferred upon Dr. Vannevar Bush, eminent engineer, beloved teacher, brilliant national leader in research in the physical sciences, prophetic seer of things to come, inspiring organizer of engineering and science in the national emergency.

D. W. R. Morgan, President ASME, conferred the honors and William L. Batt, past-president and Hon. Mem. ASME, presided. Mr. Batt was Minister of Economic Affairs to the United Kingdom, 1950–1952.

Interlingua—International Language

Interlingua, an auxiliary tongue with regular, simplified grammar and root words from many national languages, is designed to overcome language barriers faced by scientists. It is said to impress speakers of many Western languages as a modification of their native idiom.

Originated in late 1951, through the efforts of the International Auxiliary Language Association, Interlingua has progressed to a point where there are now more than ten scientific journals that publish abstracts in the new tongue. Abstracts of communications to the second World Congress of Cardiology, held in Washington, D. C., in September, 1954, were presented in Interlingua.

The Interlingua Division of Science Service was organized April 1, 1953. Alexander Gode is chief of the division. Among the many books by Dr. Gode are two on Interlingua. The division maintains headquarters at 80 East 11th Street, New York, N. Y.

The following example is taken from an issue of "Science News Letter," which was published in Interlingua. Under the heading Technologia is: "Ingenieria***Pro deteger minusculissime irregularitates in superficies plan, le laboratorios General Electric in Detroit emplea un microscopio interferential que functiona in principio per comparar duo fasces de lumine, lé un reflectite per le superficie sub examination, le altere per un superficie idealmente plan intra le instrumento. Le instrumento ha un sensibilitate que permitte le detection de irregularitates de solo 0,05 microns. (11901054/4200)"

For the first time the new international language is now being taught, in a noncredit course, at the New York University Division of General Education, adult-education unit.

Foreign delegates turned out Wednesday morning for an authors' breakfast at the First International Congress on Air Pollution sponsored by ASME. *Left to right* are: M. H. Moerel, commercial secretary, Netherland Embassy, Washington, D. C.; Dr. Umberto Saffiotti, Ente Nazionale per la Prevenzione degli Infortuni, Rome; R. L. Rees, chief chemist, British Electricity Authority, London; Dr. H. E. Newhall, Department of Scientific and Industrial Research, London; T. P. Colclough, technical adviser, British Iron and Steel Federation, London; and Dr. Louis C. McCabe, chief, Fuels and Explosives Division, U. S. Bureau of Mines, Washington, D. C.

First ASME International Congress on Air Pollution Tackles a "Universal" Problem

Sir H. E. C. Beaver delivers Rice Lecture. American and foreign engineers and scientists join forces to rout ancient scourge

More than 450 specialists from the United States and abroad gathered in New York, N. Y., March 1 and 2, to attend a world-wide conference of scientists and engineers at the First International Congress on Air Pollution.

The meeting, the first of its kind, was sponsored by the Committee on Air-Pollution Controls of The American Society of Mechanical Engineers. This was one of the events marking the year-long celebration of the Society's Diamond Jubilee Year.

With "Air-Pollution Control...A New Frontier" as the theme, authorities in the study of air pollution, representing the United States, Canada, Great Britain, The Netherlands, Portugal, Italy, and France, reported and discussed their most recent researches and developments. The technical sessions probed into the gaps in current knowledge of air pollution, air-pollution developments, sulphur dioxide—its treatment and recovery, and a report of air-pollution experience abroad.

Two excellent documentary films were shown during the meeting. A technical film, "Wind-Tunnel Scale-Model Investigation of Power Plants," depicting the only tunnel in the world designed and built specifically for air-pollution research. The motion picture shows a Los Angeles, Calif., power-plant study conducted in the air-pollution wind tunnel of New York University's Engineering Research Division, with narration by James Halitsky. The research is threefold: Preventive, corrective, and basic. "Guilty Chimneys," a motion picture presented by The Gas Council, London, England, graphically underscored that while industry was in a large measure responsible for air pollution, the fact was the home chimneys equally were "guilty."

Technical Sessions

Further research to determine the relation between air pollution and lung cancer was urged by Norton Nelson, director of the Institute of Industrial Medicine at New York University-Bellevue Medical Center. He reviewed findings in this field and the research which has been going on since 1950.

Lung-Cancer Rate Increased

"Lung-cancer rates are higher generally in urban areas than rural areas," Dr. Nelson said. "We are unable at the present time, however, to disentangle the confusing factors in this picture and so reach a clear decision."

He said that other factors besides air contamination which must be taken into consideration in the higher urban incident of lung cancer are dietary differences, occupation, and a higher frequency of smoking.

Materials collected in contaminated urban air which are known to be cancer-producing, he added, belong to a particular family of carcinogenic compounds, the polynuclear aromatics, known to be capable of producing skin cancer and "probably" lung cancer. Sulphur poured out in exhaust gases as sulphur dioxide combines with water in the air to form acid compounds that may be breathed in and irritate lung tissues. Benzpyrene, identified in the air of English cities and of Los Angeles, he said, is produced in the exhausts of automobiles and other motor vehicles.

"Unfortunately there is a critical lack of knowledge of the relationship between dose and effect for these materials. Consequently, whether the amounts found in the air of our cities are significant for lung-cancer indication in man is completely unknown."

Air-Pollution Control

Arthur C. Stern, chief, Air Pollution Control Program, U. S. Public Health Service, Department of Health, Education, and Welfare, Cincinnati, Ohio, said air pollution is recognized as a problem in 10,000 American cities, an estimate based on a detailed survey made recently in New York State, showing that 250 urban and 203 rural and suburban communities had air-pollution problems. Only 45 per cent of the urban communities in the state and 15 per cent of the rural have local air-pollution or smoke-control ordinances.

There is "no place to hide" domestic smoke and industrial fumes, Leslie Silverman, associate professor of Industrial Hygiene Engineering, School of Public Health, Harvard University, maintained.

"We are fast approaching the time when atmospheric dilution and dispersion of contaminants no longer can be done when communities lie close to facilities," he said, "like the attitude prevailing about atomic warfare, namely, no place to hide. The philosophy of building tall stacks in areas without a community nearby is reaching a similar status."

"Few places remain where industry can escape community protests against air pollution," Dr. Silverman declared. Research for the American Iron and Steel Institute at Harvard, he said, had developed a filter made of blast-furnace slag to remove harmful fumes from high-temperature-steel gases.

R. F. Davis and J. C. Holtz, both of Diesel Test and Research Section, Bureau of Mines, Pittsburgh, Pa., told of tests of diesel engines to reduce air pollution. They reported a "scrubbing" device could remove gases that contributed to the odor and irritating properties of exhausts. Application on buses and locomotives evidently is feasible.

Other speakers discussed similar devices for reducing the offensiveness of industrial and household smokes and fumes.

Sir Hugh E. C. Beaver, Chairman of the Government Committee of Enquiry into the Nature, Causes, and Effects of Air Pollution (United Kingdom), delivers the Calvin W. Rice Lecture at the First International Congress on Air Pollution

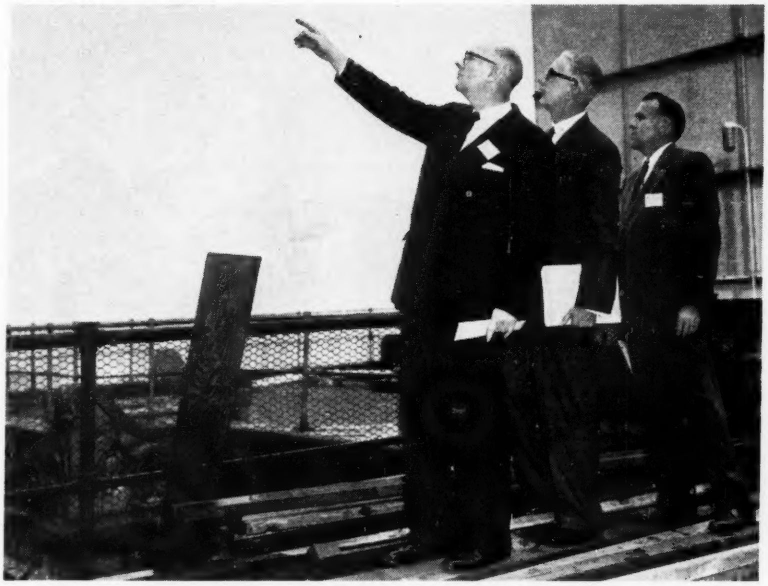
Sarnia Report

Voluntary co-operation between industry and a government industrial-research bureau is considered the best method to tackle the problem of air pollution in the Sarnia area of Ontario Province, Can., according to B. C. Newbury, research fellow, Ontario Research Foundation, Toronto, Ont., Can.

Mr. Newbury said, "We consider that it is fundamentally wrong and mildly undemocratic for a city to have to legislate against air pollution and provide an enforcement agency."

Six major industrial firms are contributing toward the cost of a survey and are actively helping one another to solve their pollution problems. The results of the survey were reflected in a surge of public interest, other industries asked to participate, a constant flow of data, co-operation has been established with the city council, and public relations have improved. Also, data are spontaneously interchanged and studies of pollution problems are kept up to date.

Mr. Newbury concluded, "Industry has the know-how, the manpower, and the facilities to do the work far better itself; legislation should be reserved for use against the nonconformers only."



New York, N. Y., lost in a smog. During First International Congress on Air Pollution, *left to right,* F. S. Mallette, executive secretary, ASME Committee on Air-Pollution Controls; Dr. H. E. Newhall of London, England; and A. H. Rose, Jr., of Los Angeles (Calif.) County Air-Pollution Control District, examine density of smog which obscured New York's skyline from Hotel Statler roof.

Sulphur Dioxide—Treatment and Recovery

During the session on Wednesday devoted to sulphur dioxide, the removal of sulphur from gases obtained from many sources was reported.

J. C. Carrington, vice-president of the Freeport Sulphur Company, estimated that the total production of sulphur in the free world amounted to more than 12 million tons in 1953. Of this, more than half was produced in the United States. Only a fraction of the American sulphur production now comes from sources other than mining, he said.

In 1949, Mr. Carrington estimated, the United States produced 57,000 tons of sulphur from refinery waste gases and by removing hydrogen sulphide from natural gas. By 1954 the output had increased to 350,000 tons of sulphur, he said.

Building 300-ft-high chimney stacks has been found a better method of minimizing air pollution near English power plants than a number of processes tested to remove sulphur dioxide from stack gases, according to R. L. Rees, chief chemist of the nationalized British Electricity Authority.

After describing in detail several processes of washing flue gases, Mr. Rees concluded that, in their present state of development, these processes are uneconomical and difficult to apply.

A report from the Tennessee Valley Authority by L. B. Hein, A. B. Phillips, and R. D. Young, all of the Wilson Dam in Alabama, said that the economic advantage of removing sulphur from coal gases, which have less of the element than does refinery gas, were not known at present. However, they explained that in case of a sudden industrial crisis sulphur might become more expensive than it now is. Then recovery of the element from gases resulting from combustion might become an important factor.

Petroleum refineries are now removing a large part of the sulphur from their gases, according to G. E. Smalley and James W. Klohr of the Ralph M. Parsons Company in Los Angeles. Los Angeles refineries are recovering 360 tons of sulphur daily; Houston refineries, 120 tons; and Philadelphia refineries are recovering 165 tons a day, they stated.

All the sulphur now recovered at refineries before it reaches the atmosphere reduces by 2000 tons a day the amount of sulphur dioxide released into the air as the result of combustion of fuel oil, was their estimate.

R. J. S. Pigott, *left,* past-president, ASME, who presided at the International Congress on Air Pollution Banquet, chats with G. V. Williamson, chairman, ASME Committee on Air Pollution Controls and vice-president, Union Electric Company of Missouri, who presided at the Calvin W. Rice Lecture

Air Pollution Abroad

"Human beings are not the only living things affected by contaminated air," said Giovanni Pancheri, director, Medical Division, Ente Nazionale per la Prevenzione degli Infortuni, Rome, Italy. He told how flora and fauna have suffered damage as a result of atmospheric pollution.

He reported an incident in which cattle died after grazing in meadows located near a factory making ironclad batteries for submarines. Faulty installation of a blower system in the plant resulted in dust of lead oxide being spread over the meadow.

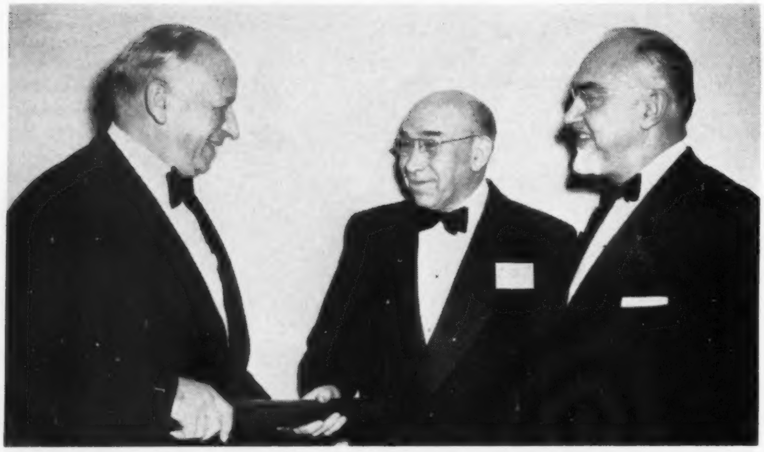
In another case, gaseous emanations from a large electrolytic aluminum plant in the Italian province of Trento, in 1927, damaged plants and killed bovines, equines, dogs, cats, and poultry. Silkworms were especially affected, dying in large numbers.

A chemical plant at Ravenna on the Adriatic Sea, he said, created atmospheric pollution to the extent that "trees yielded few fruits and vegetables did not reach the size and beauty previously obtained, while garden and ornamental plants sadly withered."

The speaker also touched on the possibility of "psychological intoxication." He described several cases where the only persons affected were women, although men were present. This, he concluded, led to the thought that there might be a psychological cause for the phenomenon of autosuggestion.

Calvin W. Rice Lecture

Sir Hugh E. C. Beaver, chairman of the Government Committee on Air Pollution in the United Kingdom, in his presentation of the



Sir Hugh E. C. Beaver, *left*, receives honorary membership in The American Society of Mechanical Engineers. Honor was conferred on the visiting Briton at the First International Conference on Air Pollution by David W. R. Morgan, *center*, ASME President. The presentation was made at a banquet before 350 engineers in Hotel Statler. Principal speaker, G. Edward Pendray, *right*, senior partner in the firm of Pendray & Company, spoke on "Management Aspects of Air Pollution."

Calvin W. Rice Lecture, said air-pollution programs and legislation will remain ineffective until public opinion has grown strong enough to support their enforcement.

Tracing a 700-year history in England of frustrated air-pollution committee after committee and legislation after legislation, Sir Hugh said that only now public opinion in England is ready for really drastic action.

Major portions of Sir Hugh's address will be published in a forthcoming issue of MECHANICAL ENGINEERING.

The Calvin W. Rice Lecture, founded in 1934, was named to honor the man who served as Secretary of the Society from 1906 to 1934.

Sir Hugh, managing director of Arthur Guinness, Son & Company, Ltd., was chosen as Rice Lecturer for his work on the air-pollution committee. During World War II he served as Director General and Controller General of the Ministry of Works. After the war he was named to Lord Reith's Committee on New Towns and to the Building Industry Working Party.

Conference Banquet

The banquet on Tuesday evening was highlighted by the presentation of Honorary Membership to Sir Hugh E. C. Beaver and the principal address delivered by G. Edward Pendray. R. J. S. Pigott, past-president ASME, served as toastmaster.

Honorary Membership was conferred on Sir Hugh for "acknowledged eminence in the engineering field" by David W. R. Morgan, ASME President.

Management Aspects of Air Pollution

The failure of American industry to recognize community-relations opportunities in air-pollution control has resulted in widespread blame of industry for air-pollution conditions, according to G. Edward Pendray, Mem. ASME, and senior partner of the New York public-relations firm of Pendray and Company.

This general criticism exists, he said, despite estimated expenditures by private industry of $1 billion in the past five years and current spending of from $100 to $300 million annually to clear up its share of the country's air pollution.

Mr. Pendray called upon industry to achieve improved employee and community relations by adopting a positive approach to the problem. He outlined several basic steps toward this goal: Recognize the existence of an air-pollution problem immediately; employ technological means promptly to remedy the problem, so far as possible; tell the public about it, frankly and simply; and face up to the fact that air-pollution problems are too often only symptoms of poor community relations by a firm. Show good citizenship in other ways as well.

The complete text of Mr. Pendray's talk will appear in an early issue of MECHANICAL ENGINEERING.

At the conclusion of the meeting F. S. Mallette, executive secretary of the ASME Committee on Air-Pollution Controls, stated that the reports, both from the United States and abroad, demonstrated that "atmospheric contamination is a universal problem."

He expressed the hope that an international committee would be established to pool ideas and exchange information of the technical developments in air-pollution control. The public is aroused to the problem and to the practicable methods that can combat it, he said. He also paid tribute to the contributions made by the press in informing the public, adding that the material used in the newsletter, "Smog News," is condensed from clippings of U. S. daily newspapers. "Smog News" is issued by the ASME Committee on Air-Pollution Controls.

Mr. Mallette disclosed that invitations from Great Britain and France were received to hold the second International Congress on Air Pollution in London or Paris.

Availability List for 1955 ASME International Congress on Air Pollution

THE papers in this list are available in separate copy form until Jan. 1, 1956. Please order only by paper *number;* otherwise the order will be returned. Copies may be purchased from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.; 25 cents per copy to ASME members, 50 cents to nonmembers.

Paper No.	*Title and Author*
55—APC-1	Air Pollution—The Growth of Public Opinion, by HUGH E. C. BEAVER
55—APC-2	The Removal of Sulphur Dioxide From Power-Plant Stack Gases, by R. L. REES
55—APC-3	The Ammonia Process for the Removal of Sulphur Dioxide From Flue Gas, by H. E. NEWALL
55—APC-4	The Sarnia Survey: Action Without Compulsion, by B. C. NEWBURY
55—APC-5	The World Supply of Sulphur, by J. C. CARRINGTON
55—APC-6	The Role of Sulphur in Iron and Steelmaking, by T. P. COLCLOUGH
55—APC-7	Experience With Air Pollution in Holland, by A. J. TER LINDEN
55—APC-8	Influence of the Size of the Dust-Collector Outlet of a Cyclone on Its Efficiency, by H. J. VAN EBBENHORST TENGBERGEN
55—APC-9	Unsolved Meteorological Problems in Air-Pollution Control, by E. WENDELL HEWSON
55—APC-10	Measurement of Average Particle Size in Aerosols by Light-Scattering, by D. SINCLAIR
55—APC-11	Biological Systems for the Identification and Distribution of Air Pollutants, by J. T. MIDDLETON
55—APC-12	Refinery Sulphur Recovery Aids Air-Pollution Control, by G. E. SMALLEY and J. W. KLOHR
55—APC-13	Management Aspects of Air Pollution, by G. E. PENDRAY
55—APC-14	Sulphur Dioxide Causing Abiotic Disease in Forest Species, by NATALINA FERREIRA DOS SANTOS DE AZEVEDO
55—APC-15	Air-Pollution Control—Administrative Needs and Patterns, by A. C. STERN
55—APC-16	Collective Intoxication in Italy Due to Atmospheric Pollution, by GIOVANNI PANCHERI
55—APC-17	Gaps in Our Knowledge of Air Pollution: Associated Health Implications, by E. A. WATKINSON
55—APC-18	Air-Pollution Control: Needed Engineering Research and Development, by L. SILVERMAN
55—APC-19	Air-Pollution Control by a Sulphur-Dioxide Scrubbing System, by CLAYTON LAWLER

High-Speed Aeronautics Conference—Major Event Marks Brooklyn Poly's Centennial Year

ASME Members contribute to success of Conference. 600 U. S. and foreign scientists and engineers in attendance

At the opening session of the Polytechnic Institute of Brooklyn's Conference on High-Speed Aeronautics are T. von Karman, *left*, who gave the keynote address, being greeted by H. S. Rogers, president of the Institute, while P. R. Bassett, chairman of the corporation, PIB, *second from left*, and Prof. N. J. Hoff look on

The High-Speed Aeronautics Conference, organized by the department of aeronautical engineering and applied mechanics of the Polytechnic Institute of Brooklyn as a feature of the Institute's Centennial Year, was held at the Engineering Societies Building, New York, N. Y., January 20–22. (See also pages 380 and 381 in this issue.)

A major centennial convocation will be held by the Institute in October. Throughout the coming months various meetings and conferences will be held on the centennial theme: "Science, Engineering, Research—for Human Well-Being," of which the conference on high-speed aeronautics is the first.

The technical program consisted of three sessions on aerodynamics and one on structures. Eight of the 19 papers delivered at the conference were contributed by members of ASME. The program also featured the official opening and inspection of the Freeport, L. I., Laboratory of the Institute.

Preston R. Bassett, president, Sperry Gyroscope Company, New Hyde Park, N. Y., presided at the opening session. Harry S. Rogers, Mem. ASME, president of the Institute, welcomed the distinguished gathering of internationally famous scientists and engineers. In the keynote address Theodore von Karman, Mem. ASME, discussed the solved and unsolved problems in high-speed aerodynamics.

Speeds to Mach 3 Predicted

Dr. von Karman indicated his belief that military aircraft would be engaged in sustained supersonic flight at speeds up to Mach 3 (over 2000 mph at sea level) within the next decade, with such flight being a common rather than occasional occurrence for military planes. He ventured no opinion as to the adoption of these speeds by commercial carriers. Turning his attention to flight at very high Mach numbers at extreme altitudes in air of very low density, Dr. von Karman outlined the greatest problem in the development of long-range missiles and, eventually, space vehicles, namely, that of the heating of aircraft surfaces due to friction. He said this so-called thermal barrier was a more formidable problem today than the sound barrier was a few years ago. The whole question of the return of missiles and craft, from the thin air to the dense earth's atmosphere, is still open and needs study.

He also discussed the transonic flow phenomena occurring when planes pierce the sound barrier, the problem in high-speed flight of the obnoxious noise of jet engines, and the loud shock wave created at very great speeds.

Looking into the future, Dr. von Karman wondered if, for commercial operations, the enormous space requirements for airfields, and the great noise nuisance in populated areas would not "lead one to think of water landing fields and the use of amphibia." He also said that military aviation calls for a radical change in take-off techniques with less dependence upon huge landing areas. Experiments with vertical take-off, rocket assistance, and catapults are directed to solving the military problem.

Aerial Whitecaps Discussed

Hugh L. Dryden, Fellow ASME, director of research, National Advisory Committee for Aeronautics, Washington, D. C., discussed the problems in high-speed flight caused by aerial whitecaps or patches of disturbance which stir up the adjacent atmosphere into a turbulent condition which might not at the moment be a desirable condition of flight. Dr. Dryden pointed up the necessity for scientists being able to understand fully the conditions which caused the transition from smooth to turbulent flow, and to develop means for generating artificial-turbulent spots so that they might be studied.

K. Oswatitsch of the Royal Polytechnic Institute of Stockholm, Sweden, reported research done on the complicated flows of air encountered near the noses of missiles and of delta wings at the vicinity of the speed of sound. Dr. Oswatitsch's findings represent simplified methods for calculating the flow properties making a large contribution to resistance.

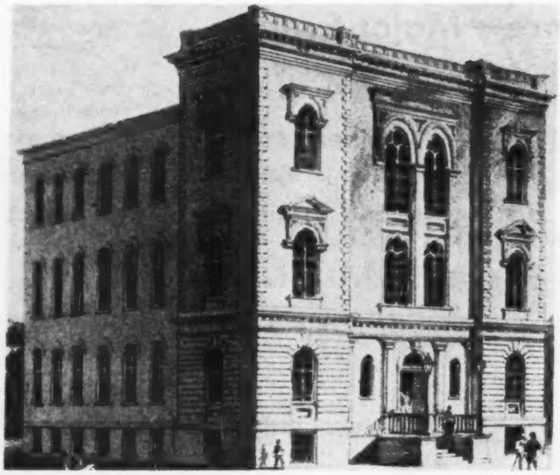
Luigi Crocco, Mem. ASME, of Princeton University, also spoke on aspects of the interaction of air flows at supersonic speeds.

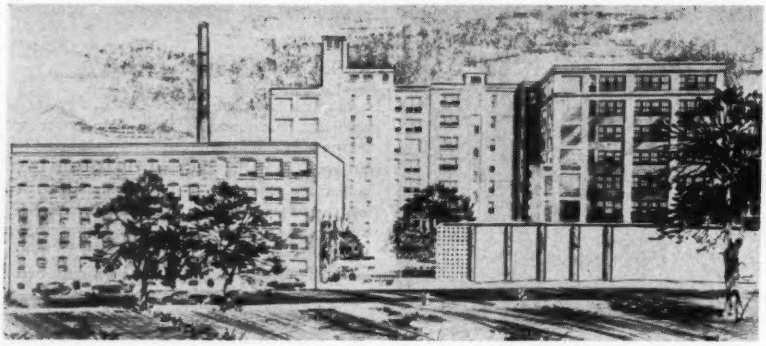
Ralph Damon Addresses Banquet

Ralph S. Damon, Mem. ASME, president, Trans World Airlines, was the principal speaker at the banquet. In his talk, "Philosophy of Air Transportation," Mr. Damon observed that the "opportunity to travel" offered by today's low-cost, swift airline travel "added much to the culture and understanding of all the peoples of the world."

On current preoccupation with speed, he raised the question whether cutting the trans-Atlantic flight time from 12 hours to four hours at speeds of Mach One would achieve the same "worth-while utility commercially as cutting the four to five-day sea-travel time to present air-travel time." However, he em-

(Continued on page 382)





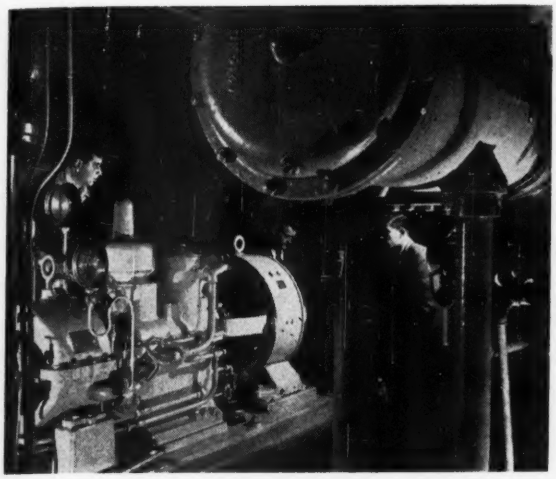
Brooklyn Polytechnic—Past, Present, and Future The Polytechnic Institute of Brooklyn, one of America's largest engineering schools, is celebrating its centennial anniversary during 1954–1955. Chartered in 1854, it admitted its first class of 267 students in 1855, forerunners of the 6400 who crowd through its corridors today. "Old 99" Livingston Street was the first home of "The Poly," but soon wings had to be added, and by 1890 the fortresslike "85" was built. Now 15 buildings in downtown Brooklyn, and a joint Air Force-Polytechnic-built Aerodynamics Laboratory at Freeport, L. I., are required to house its eight degree-granting departments. Real pioneers in evening education, Poly began night sessions in 1904.

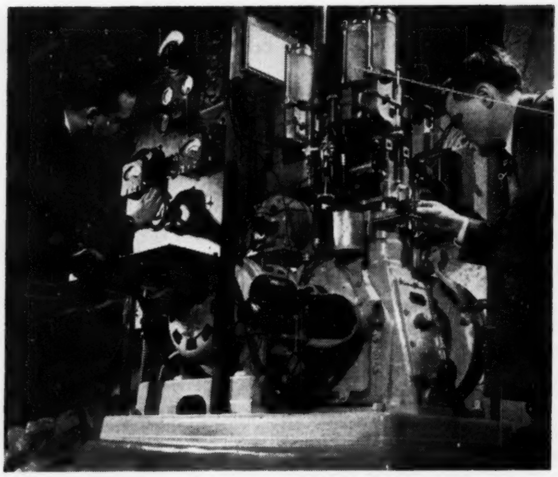
Polytechnic Institute of Brooklyn . . .

. . . 100 Years of Engineering

Rotary Honors Brooklyn Polytechnic Centennial. In left photo, H. S. Rogers, *right*, president, Polytechnic Institute of Brooklyn, accepts framed citation honoring the Institute's Centennial Anniversary from Andrew S. Roscoe, president, South Brooklyn Savings and Loan Association, who made the presentation for the Brooklyn Rotary Club at Hotel St. George, January 12

High-Speed Aeronautics Luncheon. In right photo, T. von Karman, *left*, chief aeronautical research adviser to the U. S. Air Force and NATO, and Hugh L. Dryden, director of research NACA, chat during the High-Speed Aeronautics Luncheon





Velocity-compounded turbine, *above*, with gear-reduction unit and d-c generator under test in Institute power laboratory. Exhaust steam passes into the surface condenser overhead in the foreground.

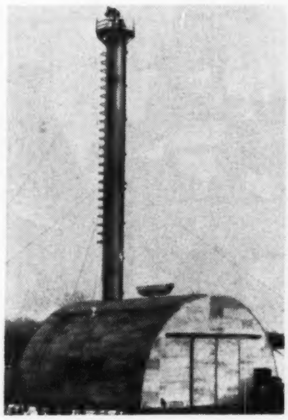
Co-Operative Fuel Research (CFR), *above right*, engine used to determine "knock" characteristics or octane rating of internal-combustion fuels as well as for efficiency studies

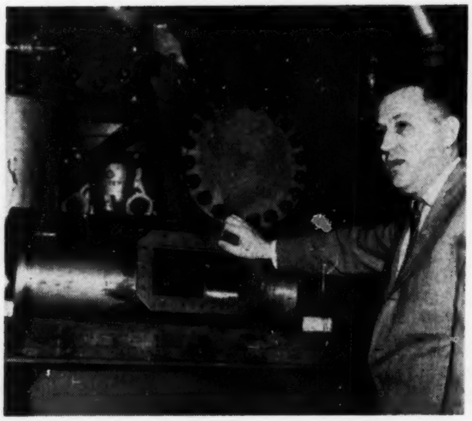
Disastrous vibrations may occur when rotating parts of machines are not properly balanced. This dynamic balancing machine, *right*, in the mechanical-analysis laboratory is being used to test the armature of a small motor.

Mechanical-Engineering Department **curriculum at Polytechnic Institute was approved in 1899. The doctorate program in mechanical engineering was recently established. Today about 1200 students are studying in Polytechnic Institute's mechanical-engineering department, day and night.**

Research Program **of the mechanical-engineering department has been growing during the recent past. Among the most recent projects completed have been a crankcase ventilation analysis, procedures in brake testing, brake design, the use of plastic models in crankshaft analysis. Many projects were reported in NACA Technical Notes. A current project of wide interest is a theoretical and experimental study of the losses in turbomachines due to the clearance between the tips of the moving blades and the stationary casing.**

Hypersonic tunnel installation, exterior view, *left*, Dr. A. Ferri, *right photo*, director of Aerodynamics Laboratory, lectures to visitors in Quonset housing hypersonic wind tunnel, Freeport, L. I., Saturday afternoon, January 22. This inspection trip was a high light of the High-Speed Aeronautics Conference. Dr. Ferri is standing beside the tunnel-section proper built beneath the 10-ft-high base of the 70-ft-high, 4-ft-diam tower.





phasized that he was not one of those who cried "this far and no further can we go in speed."

N. J. Hoff, Mem. ASME, head of the department of aeronautical engineering at Polytechnic Institute, was toastmaster at the banquet. Capt. John L. Pritchard presented an illuminated scroll of felicitations to Dr. Rogers on behalf of the Royal Aeronautical Society of Great Britain.

Drag and Noise Covered

The discussion in the second aerodynamics session was led by W. R. Sears, director, Graduate School of Aeronautical Engineering, Cornell University. The papers covered the relation between minimizing drag and noise at supersonic speeds, some general criteria for minimum wave drag at supersonic speeds, experimental study of the lifting profile at transonic speeds, and some problems of cascade flow.

Structures

Dr. Hoff, who is also chairman of the ASME Applied Mechanics Division, proposed that structural defects, under control, be designed into the hypersonic-speed guided missiles now being developed for defense and to extend man's knowledge of the universe, alike.

His suggestion proposes that a known and predictable creep factor be designed into missiles since they are in flight at the most a few minutes and do not carry personnel in any case. This would speed up the development of faster and more versatile missiles, which would not have to wait the development of new alloys before being put into production.

If engineers, Dr. Hoff pointed out, can get a thorough understanding of the effect of creep upon structures so interference with the delicate internal mechanisms and equipment of rockets and missiles can be avoided, there should be no reason why the structural changes cannot be absorbed into the design by the planners.

W. H. Horton, of the Royal Aircraft Establishment at Farnborough, England, in his paper, outlined the effect of kinetic heating, due to the friction developed at high speeds, upon aircraft structures. Because of the deterioration and modifications in structures caused by the high temperatures, some future military planes might have to be considered expendable after relatively brief life spans, he pointed out.

To solve the heating problem, new alloys, new metals, and even ceramic coatings have been tested. French designers have experimented with reinforced-concrete wings, indicating the imaginative efforts being expended to find a solution to the heating problem. Refrigeration engineers are trying to develop cooling systems.

Luigi Broglio, Life Mem. ASME, director, Scuola Ingegneria Aeronautica, University of Rome, Rome, Italy, spoke on the balance method applied to thermal-stress analysis in high-speed aircraft structures.

Capt. J. L. Pritchard, *right,* member of Royal Aeronautical Society, London, England, presents an illuminated scroll of felicitations on behalf of his society to H. S. Rogers, president, Polytechnic Institute of Brooklyn, at the conference banquet

High-Speed Test Facilities

Frank L. Wattendorf, Mem. ASME, director, Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization, Paris, France, was chairman of the third session on aerodynamics held on the morning of January 22. Papers covered test facilities for ultrahigh-speed aerodynamics, strong shock waves, and recent work in supersonic and hypersonic aerodynamics of Brooklyn Poly.

Freeport Laboratory

The afternoon was devoted to an inspection of the wind tunnel and official opening of the Institute's Freeport, L.I., Laboratory.

A distinctive feature of the facility is a novel preheating system for the air to be shot through the tunnel at speeds expected eventually to reach 15 times the speed of sound.

The heating is required to keep the air, released from high compression, from cooling to temperatures significantly below those that would be encountered by guided missiles in their flight through the atmosphere.

A 70-ft tower is the chamber where the preheating takes place. Compressed air stored outside in containers is piped into the top of the tower. It pushes down a piston that compresses the air to be used in the tunnel.

The laboratory is under the direction of Dr. Antonio Ferri.

***Left to right,* Major L. D. Gardner, retired aeronautical researcher; J. G. Hunsaker, Hon. Mem. ASME, department of aeronautical engineering, Massachusetts Institute of Technology; and Rear Admiral Robert S. Hatcher, Bureau of Aeronautics, Washington, D. C., attend High-Speed Aeronautics Luncheon**

EJC Proceedings Available

The Board of Directors of Engineers Joint Council has authorized the publication of the proceedings of the General Assembly of Jan. 21, 1955, to be available, at $1 a copy, about April 1. Requests, with remittances, should be sent to Engineers Joint Council, 29 West 39th Street, New York 18, N. Y.

ASME Calendar of Coming Events

April 6
ASME Machine Design Division Conference, as part of the Centennial Celebration, New York University's College of Engineering, New York, N. Y.

April 16
ASME Organization Anniversary Meeting, Stevens Institute of Technology, Hoboken, N. J. *(No formal papers will be presented)*

April 18–21
Diamond Jubilee Spring Meeting, Lord Baltimore and Southern Hotels, Baltimore, Md.
(Final date for submitting papers was Dec. 1, 1954)

April 25–26
ASME Instruments and Regulators Conference, University of Michigan, Ann Arbor, Mich.
(Final date for submitting papers was Dec. 1, 1954)

June 5–10
ASME Oil and Gas Power Conference, Hotel Statler, Washington, D. C.
(Final date for submitting papers was Feb. 1, 1955)

June 15–17
ASME and The Institution of Mechanical Engineers, London, England, Joint Conference on Combustion, Massachusetts Institute of Technology, Cambridge, Mass.
(Final date for submitting invited papers was Nov. 1, 1954)

June 16–18
ASME Applied Mechanics Conference, Rensselaer Polytechnic Institute, Troy, N. Y.
(Final date for submitting papers was Feb. 1, 1955)

June 19–23
Diamond Jubilee Semi-Annual Meeting, Hotel Statler, Boston, Mass.
(Final date for submitting papers was Feb. 1, 1955)

Sept. 12–14
West Coast Committee of the ASME Applied Mechanics Division, 1955 Western Conference on Applied Mechanics, U. S. Naval Post-Graduate School, Monterey, Calif.
(Final date for submitting papers—May 1, 1955)

Sept. 12–16
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Los Angeles, Calif.
(Final date for submitting papers—May 1, 1955)

Sept. 25–28
ASME Petroleum-Mechanical Engineering Conference, Roosevelt Hotel, New Orleans, La.
(Final date for submitting papers—May 1, 1955)

Oct. 10–12
ASME-ASLE Second Lubrication Conference, Antlers Hotel, Indianapolis, Ind.
(Final date for submitting papers—June 1, 1955)

Oct. 19–20
ASME-AIME Joint Fuels Conference, Neil House, Columbus, Ohio
(Final date for submitting papers—June 1, 1955)

Nov. 13–18
Diamond Jubilee Annual Meeting, Hotel Congress, Chicago, Ill.
Final date for submitting papers—July 1, 1955)

Junior Forum . . .

Conducted by R. A. Cederberg,[1] Assoc. Mem. ASME

Week-End Sessions at National Meetings

By Leonard Linten,[2] Assoc. Mem. ASME

In attending national meetings of The American Society of Mechanical Engineers I have noted that the attendance has been somewhat less than might be expected. The membership now exceeds 40,000 with a potential of many more thousands. Total registration at these meetings seems to run around 1200. When one considers that this figure includes members as well as nonmembers it is not impressive and if you look around you will note that, among those who do attend, there are not many young people. Inasmuch as the subject matter and presentations are of a high caliber it would appear that the lack of attendance is due to factors other than these.

Week-End Meetings Suggested

I would like to make a suggestion that would attract a lot of the younger men to the meetings—that the dates of the meetings be moved forward or backward to include Saturday and Sunday, or the meetings lengthened to include these days.

The advantage of holding week-end sessions would appear to more than outweigh the disadvantages. The negative opinion would be held by some members who would prefer having the week end for their own use. However, a well-developed week-end program would most likely win over many from the ranks of this group. A lot of us younger members cannot get time off to attend the morning and afternoon sessions held during the week. It is usually only those in sales or in an executive capacity who can attend. The younger engineers are frequently not in these groups and are not encouraged to attend sessions during the regular working period. In a large engineering organization only a small number can attend, and then usually for only a limited period of time Of course this is as it should be. Few companies could afford to have the bulk of their engineering departments spending a large amount of time away from work. The writer knows of several members who requested to attend certain daytime technical sessions related to their field of activity and were turned down. I am sure that if I personally am acquainted with several such cases, there must be hundreds of similar cases across the country.

Encourage Attendance

If technical sessions were held on Saturday and Sunday, this group, as well as persons who do not or prefer not to attend weekday sessions due to the urgency of normal activities, could attend more of the sessions—and with a free mind. These week-end sessions would affect both those living in the metropolitan area of the city in which the meeting is being held as well as those who live some distance away.

A well-developed week-end program that included activities of interest to a member's family, such as technical and nontechnical tours, tea dances, theatre parties, dinner dances, and the like, would give The American Society of Mechanical Engineers more of a family relationship. The Woman's Auxiliary to the ASME would most likely play a key role in planning many of the social activities.

The younger engineers would, by attending and participating in a greater number of meetings, take a more active part in the Society. This would certainly tend to hold their interest in the organization. In attending the meetings, they would overcome the feeling so frequently expressed that they are "not getting anything out of" the Society. They often feel that the annual dues do not cover the value they receive by reading Mechanical Engineering—when they find the time. Increased attendance at meetings would result in greater membership participation in the sessions. This in turn would tend to reduce the number of members who drop out of the Society.

It is my understanding that the Old Guard contributes funds for special activities designed to encourage greater Society participation. Perhaps they would be interested in helping this suggestion become a reality.

Yes, these week-end sessions could well turn out to be one of the most important activities that the Society has undertaken in many years.

[1] Westinghouse Electric Corp., Radio-Television Division, Metuchen, N. J.

[2] Assistant Project Engineer, Wright Aeronautical Division, Curtiss-Wright Corp., Wood-Ridge, N. J.

. . . Chairman's Corner[3]

Baltimore Spring Meeting—Wonder how many of you are planning to attend the Baltimore Spring Meeting, April 18–22. If you do not live in or near Baltimore, Md., you might give some thought to a car pool. You could drive to Baltimore on Saturday, see the sights, and catch at least a couple of days of the Meeting. You might even want to plan a visit to Washington, D. C., which is only a few miles from Baltimore. If you can get to Baltimore, read on because at 3 o'clock Monday afternoon, April 18, we are planning an informal meeting for the 12 guests of the Old Guard and a num-

[3] Chairman of National Junior Committee, Charles T. Miller, Engineering Division, Wright Aeronautical Division, Curtiss-Wright Corp., Wood-Ridge, N. J.

ber of dignitaries of the Society. You will be welcome. Check the information desk at the Lord Baltimore for the room number. Based on similar meetings held in the past, I believe you will really get a lot out of this session.

On Monday evening at 8 o'clock the Junior session will be held. The theme is "The Engineer as a Public Employee." We have lined up two excellent speakers for this event; Samuel S. Baxter, Commissioner, Department of Water, City of Philadelphia, will discuss the advantages, problems, and rewards of full-time public employment for engineers, and Henry A. Barnes, Director of Traffic, City of Baltimore, who will speak on the service an engineer can render to society by contributing his engineering knowledge to various civic activities on a part-time basis. If you cannot get to Baltimore, keep in mind the Boston Meeting in June and the Chicago meeting in November.

Gas-Turbine Division—The Gas Turbine Committee tells me that they are in need of a few younger members of the Society who can and will devote a little time and effort to committee work. This looks like a good place to get into committee work on a national level. If you are interested drop me a note at 29 West 39th St., New York 18, N. Y., and I will advise the Committee of your interest.

Actions of the ASME Executive Committee

At a Meeting at Headquarters, Feb. 15, 1955

A Meeting of the Executive Committee of the Council was held in the rooms of the Society on Feb. 15, 1955. David W. R. Morgan, chairman, presided. In addition to Mr. Morgan, there were present: Frank L. Bradley, Thompson Chandler, Willis F. Thompson of the Executive Committee; L. N. Rowley, Jr., chairman, Finance Committee; J. W. Barker, chairman, Organization Committee; J. L. Kopf, treasurer; E. J. Kates, assistant treasurer; L. K. Sillcox, past-president; W. H. Byrne, vice-president; R. B. Lea, H. C. R. Carlson, J. H. Davis, and Joseph Pope, directors; C. E. Davies, secretary, O. B. Schier, 2nd, T. A. Marshall, Jr., and D. C. A. Bosworth, assistant secretaries.

Dinner Meeting

A dinner meeting was held at The Engineers' Club, New York, N. Y., Feb. 14, 1955, at which members of the Executive Committee met with ASME representatives on United Engineering Trustees, Inc., The Engineering Foundation, and the Engineering Societies Library Board. The following were present: D. W. R. Morgan, F. L. Bradley, and Thompson Chandler of the Executive Committee; W. H. Byrne, H. C. R. Carlson, R. B. Lea, and L. K. Sillcox, members of Council; E. J. Kates, assistant treasurer; L. N. Rowley, Jr., Finance Committee; C. E. Davies, secretary, and O. B. Schier, 2nd, assistant secretary; J. L. Kopf, ASME representative on UET; R. C. Allen and E. L. Robinson, ASME representatives on The Engineering Foundation; Theodore Baumeister, ASME representative on the Library Board; John H. R. Arms, secretary, UET; and Ralph H. Phelps, director of the Library.

Theodore Baumeister reported briefly on the scope of the Library's operation and then called on Ralph H. Phelps, who emphasized the need for more space and answered questions raised by members of the Executive Committee. E. L. Robinson and R. C. Allen spoke briefly on the work of The Engineering Foundation.

J. L. Kopf asked L. K. Sillcox to report on the meeting of the Committee of Five Presidents held Feb. 1–2, 1955, after which a discussion was held as to the next steps to be taken regarding a new engineering building.

Revised Budget for 1954–1955

Upon recommendation of the Finance Committee the Executive Committee of the Council voted to approve the revision of the budget for 1954–1955. This shows an additional income of $7960, making the total for the year $11,395.

Support of Student Branches

The Executive Committee voted to add Paragraph 16 to the statement of Policies for the 1954–1955 Budget as follows:

Par. 16 Payments to the Student Branches for operation shall be on the basis of: 15 through 50 Student Members—$25; for the next 50 Student Members—50 cents per Student Member; and for all over 100 Student Members—25 cents per Student Member.

Society Aims and Objectives

Upon recommendation of the Organization Committee at its Feb. 14, 1955, meeting, the Executive Committee voted to charge the Organization Committee with the duty of making a study and résumé of the forward aims and objectives of ASME, a progress report which is to be made at the 75th Anniversary Annual Meeting, November, 1955. The Organization Committee was empowered to establish temporary subcommittees and to appoint necessary additional members representing all phases of ASME activities.

1955 Awards

The following awards and honors for 1955 were approved:

ASME Medal to Granville M. Read, Mem. ASME, Wilmington, Del.;

George Westinghouse Gold Medal to Hyman G. Rickover, Washington, D. C.;

Holley Medal to George J. Hood, Lawrence, Kan.

The Committee voted to confer the Spirit of St. Louis Medal and the Spirit of St. Louis Junior Award during 1955, because of the 75th Anniversary of the Society. Previous awards were made in 1950 and 1954.

It was voted to award the 1955 Spirit of St. Louis Medal to Ralph S. Damon of New York, N. Y.

International Conferences on Steam Properties

During the Fourth International Conference on the Properties of Steam in September, 1954, it was suggested that ASME, through its Research Committee on Properties of Steam, serve as the secretariat for international conferences on the properties of steam and the interchange of information of interest to countries concerned. The Research Committee on Properties of Steam was authorized to serve as the secretariat for such international conferences with the understanding that extraordinary staff expense to carry out this work will be provided in the Custodian Fund for the research project.

Special Committee on Review of Procedure for Honors

On recommendation of E. G. Bailey, chairman, Special Committee on Review of Procedure for Honors, it was voted to add the following two members to this special committee: William L. Batt, Philadelphia, Pa., and D. Robert Yarnall, Philadelphia, Pa. Complete personnel of the Committee is as follows: E. G. Bailey, chairman; W. L. Batt, E. W. O'Brien, A. A. Potter, and D. Robert Yarnall.

Applied Mechanics Reviews

The Secretary reported that a check for $10,000 had been received from the National Science Foundation as a grant for partial support of *Applied Mechanics Reviews.*

Certificates of Award

The following retiring chairmen of Boards and Committees were granted certificates of award: J. H. Harlow, Board on Membership; T. R. Olive, Board on Technology; and J. K. Louden, Meetings Committee.

Certificates were granted to the following retiring members of the Boiler and Pressure Vessel Committee: Albert C. Weigel, 1932–1953; Robert E. Cecil, 1932–1953; Perry R. Cassidy, 1939–1954; and Paul Diserens, Subcommittee on Unfired Pressure Vessels, 1931–1954.

Two retiring chairmen of Sections were also granted certificates: Frank L. Schwartz, Detroit Section, and Lauren E. Seeley, Green Mountain Section.

New Engineering Building

The Executive Committee noted the com-

munication from the Committee of Five Presidents, dated Feb. 2, 1955, recommending "that the headquarters of the engineering societies be located in Pittsburgh, Pa." and that the Committee of Five Presidents be discharged. It noted also that the Boards of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, and the American Institute of Electrical Engineers had withheld action on the recommendation.

The Executive Committtee discussed ways of securing joint action by the five societies concerned on a new engineering center. It debated the merits of continuing the Committee of Five Presidents and discussed the relationship between that Committee and the United Engineering Trustees, Inc. It was felt that a suitable procedure must be developed to carry out the intent of the informal meeting in Chicago on April 6, 1954, and the parallel actions taken by the five societies.

It was voted to invite the Executive Committees, or representatives of Boards, of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Institute of Electrical Engineers, and the American Institute of Chemical Engineers to meet with the ASME Executive Committee at the earliest possible date to determine future procedure for establishing the engineering center.

EJC Membership

On recommendation of the Engineers Joint Council, it was voted to approve, as one of the constituent bodies of EJC, the admission to membership in EJC of the American Society of Refrigerating Engineers and the American Institute of Industrial Engineers as Constituent and Associate Members, respectively.

Engineering Societies Personnel Service, Inc.

It was voted to appoint O. B. Schier, 2nd, ASME representative on the Board of Directors of Engineering Societies Personnel Service, Inc., to replace Secretary C. E. Davies.

Knolls Atomic Power Laboratory

The Executive Committee on May 21, 1954, authorized an appropriation of $10,000 for fundamental research work on the Knolls Atomic Power Laboratory, operated by the General Electric Company for the U. S. Government. The research work is on design of piping for high-temperature service, with direct reference to the problem of expansion and flexibility.

An agreement for this research work has now been submitted by General Electric.

It was voted to authorize the Secretary to sign the agreement with the Knolls Atomic Power Laboratory and with the Schenectady Operations Office of the U. S. Atomic Energy Commission for research work "to substantiate the basis for ASME's approach for establishing limits of failure in pipe by cyclic stressing at high temperatures for the recently revised ASA-B-31 Code for Pressure Piping."

GM Engineering Journal

Permission was granted to the *General Motors Engineering Journal* to reproduce the ASME emblem in one of its issues in connection with the General Motors people who spoke at the ASME Annual Meeting, November, 1954.

D. S. Jacobus

The death of D. S. Jacobus at the age of 93, on Feb. 11, 1955, was noted with regret. He served as President of the Society in 1916 and was elected an Honorary Member of the Society in 1934.

Mrs. Ernest Hartford

It was with deep regret that the Executive Committee learned of the death of Mrs. Ernest Hartford on February 14. The Secretary was requested to extend its sincerest sympathy to Ernest Hartford and family.

Region VI Appointment

The appointment of Edward F. Obert as Region VI representative on the Membership Development Committee was noted.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members, or nonmembers and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Director of Engineering, plastics, rubber, chemicals; 38, registered; BSME; 15 years in process industries with top-administration responsibilities; experienced in consulting work and direction of large engineering projects; engineering-economic studies, development, design, and construction. Me-197.

Engineering Executive, 20 years' experience supervising chemical and textile-plant improvements. Available for responsible position directing engineering for multiplant organization. Me-198.

Mechanical Engineer; registered; 28; BSIME; four years' experience in plant and maintenance engineering including construction projects in paper mill; two years' experience estimating, design, field engineering, and piping contractor. Me-199.

Executive Engineer; 42; BME; 21 years in electric-utility industry. Wide experience in administration, special operating studies, liaison with plant supervisors, and employee relations. Desires supervisory or staff position. Me-200.

Executive Engineer, broad manufacturing, construction, maintenance, design, and quality-control experience, seeks responsible administrative position as assistant to or on staff of top-management official. Me-201-98-Chicago.

Manufacturing or Process Engineer; 45; BME; 13 years supervising all technical phases of production-planning or manufacture engineering, including automation and cost-reduction methods, plant and design engineering. Desires position as plant manager or manufacturing engineering executive. Me-202-99-Chicago.

Mechanical Design Engineer; 33, married; BSME; registered; eight years' experience with special machinery, materials-handling, and process-plant equipment. Resourceful, co-operative, with creative ability, and initiative. Me-203-210-D-San Francisco.

[1] All men listed hold some form of ASME membership.

Industrial Engineer, MS; business administration; 33; three years production engineering; five years metalworking operations and processes. Experienced in personal contact. Desires staff industrial-engineering responsibility in planning, methods, procedures analysis. Me-204.

Editor, 30; BSME; three years' trade-paper experience. Desires position with publication or preparing technical publicity for manufacturer including case histories, house organ, and technical articles. Me-205.

Building Equipment Engineer; 25 years supervisory and administrative positions large building and plant piping and equipment installations covering layout, estimating, purchasing, field supervision, sales, operation and project management; seeks permanent position similar capacity in Southern state. Me-206.

Positions Available

Assistant Engineer, mechanical, ten to 15 years' experience reviewing designs and estimates on all mechanical phases in a large mining operation, involving large mechanical equipment such as power-plant shovels, trucks, or handling railroad equipment and shops, etc. Knowledge of Spanish desirable. $10,500, plus or minus, in addition to living allowance of $260 a month. South America. F-1003.

Engineers. (*a*) Director of engineering, 40–50, graduate mechanical, at least 20 years' experience; with ability and know-how in machine design, to be top executive reporting to president of company. Must have proved record of administrative ability. Salary open plus bonus. (*b*) Project engineer, 35–50, graduate mechanical, at least 15 years' experience. Will work for a company primarily engaged in machine design such as steel-forming equipment solder-type mills, forming mills, pipe mills, etc. Applicant must know general construction of machinery. Salary open plus bonus. Ohio. W-1012.

Engineers. (*a*) Product engineer, 35–45, mechanical or electrical graduate, capable of running own department, including laboratory testing and general engineering. Should have experience in instrument field, i.e., pressure and liquid

gages, indicators, thermometers, etc. $7500–$9500. (b) Manufacturing engineer, 35–45, to head up all machinery programming, manufacturing processes. $7000–$9000. New York State. W-1015.

Engineers. (a) Factory manager, under 35, mechanical or industrial-engineering graduate, at least five years' experience covering precision production, production control, quality control, costs, etc., in aircraft-electromechanical field. $10,000–$15,000. Must be citizen. (b) Design engineer, under 35, mechanical or electrical, at least five years' experience covering design of aircraft-control accessories to design electrohydraulic servomechanisms. (c) Chief production engineer, mechanical or electrical, at least ten years' aircraft-accessories experience, to supervise design for production and tool engineering. New York State. W-1036.

Assistant to President, administrative and office-management experience in heating, ventilating, plumbing, and air-conditioning fields for staff duties with consulting engineering firm. $10,000–$12,000. New York, N. Y. W-1061.

Instructor or Assistant Professor, to teach industrial engineering. Opportunity to work for advanced degrees. Instructor, $3420–$3960; assistant professor, $3980–$4520 per academic term; summer-school teaching available. South. W-1068.

Manager for Standards Department, experienced in time study, methods, and costs; must know machine-tool operations; a knowledge of MTM methods. Man must have experience in a type of industry dealing with one shot as well as straight-line production. Salary open. New England. W-1072.

Director of Engineering and Design, considerable experience in small hand-electric tools. Knowledge of casting and series-wound motors. $12,000–$15,000. Midwest. W-1078.

Assistant Vice-President, young, preferably mechanical graduate, with thorough experience and background in financial economics, systems accounting, and stockholder reports and relationships. $10,000–$12,000. New York, N. Y. W-1079.

Director of Engineering, 30–40, graduate, experience handling mechanical-engineering problems of development and design in a competitive market; should have sound judgment in the practical application of devices; be promotional-minded. $12,000–$18,000. Midwest. W-1084.

Associate or Assistant Professor, to teach mechanics, thermodynamics, and aerodynamics in mechanical-engineering department. Man with graduate work and MS or doctor's degree preferred. Salary open. Pa. W-1093.

Industrial-Engineering Consultant, about 30, graduate mechanical, at least six years' experience in industry, preferably hard-goods line. Should have experience in one or more of the following areas in hard-goods manufacturing: Manufacturing engineering processing, industrial engineering, or production control. Must be willing to travel. Headquarters, New York, N. Y. W-1095.

Engineers. (a) Assistant plant manager, 28–40, mechanical, at least five years' experience in rolling mill or electrical-contact production; knowledge of alloys and bimetal bonding helpful. Will assist plant superintendent in operation of manufacturing division for company producing electrical contacts. To $7000. East. (b) Sales engineer, electrical, mechanical, or metallurgical, at least two years' experience in sale of thermostatic products and components; knowledge of electromechanical appliances helpful. Will sell OEM's and general industrial accounts as direct representative for manufacturer of electrical contacts and thermostatic products. Should be willing to travel for short periods. To $7500. Headquarters, East. W-1103.

Industrial Engineer, graduate, 25–30, experienced in planning, methods, layout, and time study. $6000–$7500. Ohio W-1107(a).

Design-Development Engineers, mechanical graduates, for the field of electromechanical instrumentation; with a sound knowledge of physics in optics and electricity; experience in design in automatic, continuous-film camera. $10,000. Conn. W-1119.

Instructors, MS in mechanical engineering preferred, but will consider BS, for teaching heat-power courses, mechanical laboratory, and applied mechanics. New England. W-1120.

Production Engineer, methods and production experience in sheet-metal and aluminum fields covering household products. $8000–$10,000. Brooklyn, N. Y. W-1122.

Assistant to Chief Engineer, 30, graduate mechanical, background in the design of machine tools or similar heavy machinery. Duties would include possibly some design work, investigations, reports, liaison between engineering and production of other departments, etc. Salary open. N. J. W-1135.

Staff Engineer, 28–32, mechanical, experience covering design and layout of conveyers and processing facilities. Some traveling to plants in East on surveys and project engineering work in materials-handling fields. $6000–$7000. Newark, N. J., area. W-1141.

Project Engineer, to assume primary responsibility for all the design, development, standardization, and product redesign of gas controls. Experience in the development of temperature-control mechanisms extremely valuable. To $10,000. Northern N. J. W-1166.

Assistant to Manager of Technical Services, 32–45, preferably mechanical, textile-machinery experience, to supervise technical service with licensees, design of new machinery, improvements on present equipment, and liaison with manufacturers. New York, N. Y. W-1168.

Instructor or Assistant Professor, MSME, to teach heat subjects and normal mechanical-engineering laboratories. Should be active in technical and professional organizations. Salary and academic rank open. Position starts September, 1955. Midwest. W-1169.

Mechanical Engineer, graduate, several years' experience in the supervision of large shops comprising machine, plate, and welding, iron, steel, and brass foundries. Must have a working knowledge of Spanish. About $10,000. South America. W-1174(b).

Sales Engineer, 26–35, mechanical or chemical engineering graduate, industrial sales experience in process equipment, industrial refrigeration, or industrial gases. $6000–$8000. Pa. W-1192.

Assistant Chief Engineer, mechanical graduate, at least ten years' design experience on hydraulic presses, special machinery, and control equipment. $10,000. N. J. W-1194.

Engineers. (b) Project engineer, mechanical, experience in planning, scheduling, and supervising tool design, tool manufacturing, component-part manufacturing, purchasing, inspection, and production of small-precision electromechanical devices. $7000–$8000. (c) Instrument designer, preferably mechanical, experience in the design of the mechanical aspects of newly developed instruments including spring design, strength of materials, production methods, and processes. $6200–$7200. Pa. W-1199.

Filtration Engineers. Company has openings for development engineer, sales manager, and field supervisor, preferably with experience in lubricating, insulating, and cutting-oil filtration. Permanent positions with excellent future. Apply by letter giving education, experience, and previous earnings. East. W-1206.

Engineers. (a) Sales engineer, mechanical, office and field-sales experience covering turbines, pumps, and accessories. $6000–$7800. (b) Application engineer, mechanical, for office engineering covering pumping equipment. $4500–$5700. (c) Design engineer, mechanical, design and development experience, covering centrifugal power-plant equipment. $6000–$7900. (d) Assistant engineer, mechanical, young, with design, application, testing, and field experience covering steam-power equipment. $4700–$6300. (e) Junior engineer, mechanical-engineering training, to perform general engineering duties in connection with design, application, testing, and field problems, covering curves, graphs, and charts; theoretical and applied mechanical analysis involving hydraulics, thermodynamics, gearing, strength of materials, etc. $4000–$5200. N. J. W-1207.

Sales Engineer, engineering background, preferably mechanical, to 35, who has an interest in, and a definite liking for, sales for a distributor of hydraulic and pneumatic equipment, auxiliary equipment on plastic molding presses, etc. Company will train. Must have car. Salary plus commission. Territory, northern N. J. Headquarters, New York, N. Y. W-1215.

Plant Engineer, at least five years' experience in maintenance and operation of power-plant, mechanical equipment and kilns; knowledge of melting operations desirable. Will handle complete plant-engineering problems on above equipment. $7500–$10,000. Employer will negotiate fee. Wis. C-2667.

Tool and Methods Engineer, mechanical or industrial, 30–35, at least five years' experience in tooling and processing in light manufacturing industry; knowledge of plastics, fiberwood, metals, glass, and adhesives helpful. Will do tooling and methods work in light manufacturing plant. $6000. Employer will pay fee. Iowa. C-2677.

Senior Application Engineer, mechanical, electrical, or physics graduate, 30–40, at least four years' experience in servo systems and their uses; knowledge of instrumentation and automation, for application and sales of servo systems. $6000–$7800. Employer will pay fee. Some traveling. Ill. C-2710.

Assistant Plant Manager, 40–55, at least ten years' experience in managing a tool-and-die job shop and preferably with a knowledge of plastics. Will be number-two man in tool-and-die plastics job shop, covering engineering, sales, estimating, and supervision of shop. $8000–$10,000. Employer will pay fee. Iowa. C-2716.

Development Engineer, mechanical or electrical, 38–50, at least ten years' experience in development field in duplicating or small mechanical products. Will develop ideas into a workable type of mechanisms, directing model shop and carry through to production, for a manufacturer of office equipment. $7500–$9900. Ill. C-2732.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after April 25, 1955, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

Key to Abbreviation

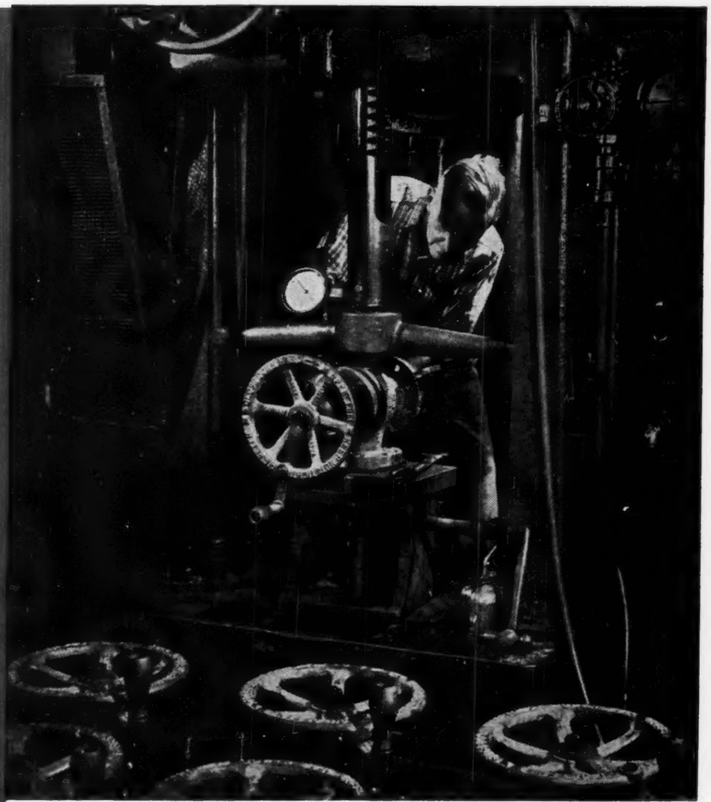
R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

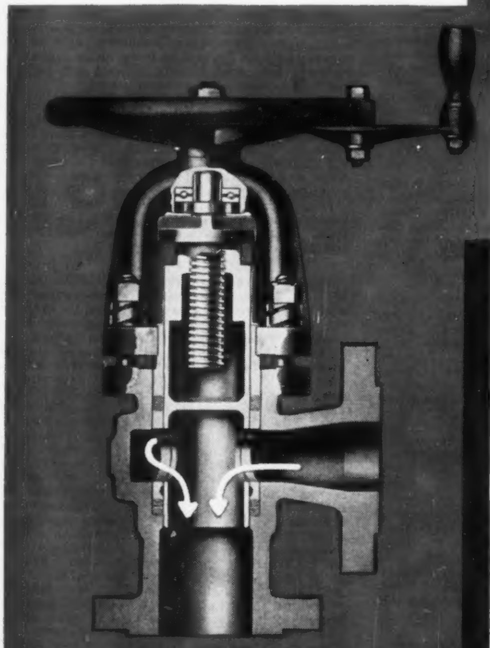
New Applications

For Member, Associate Member, or Affiliate

ALTEKRUSE, JOHN L., Cuyahoga Falls, Ohio
ASHBURN, ANDERSON, New York, N. Y.
ASHLEY, GORDON S., Pensacola, Fla.
BAER, RUSSEL F., Sylacuaga, Ala.
BAHM, WILLIAM J., Charlotte, N. C.
BARCLAY, RALPH G., Washington, D. C.
BARR, FREDERICK E., Corning, N. Y.
BATES, GARDNER O., Tulsa, Okla.
BATH, CLIFFORD K., Berwick, Pa.
BEASLEY, ROBERT, Cuyahoga Falls, Ohio
BEYER, ROBERT J., Birmingham, Ala.
BIGELOW, ROBERT E., Westbury, L. I., N. Y.
BLIONAS, COSTAS, New York, N. Y.
BOWEN, GEORGE W., Floral Park, N. Y.
BRAUN, CLYDE R., Wauwatosa, Wis.
BRAZELL, DOUGLASS L., Borger, Texas
BREISCH, ROBERT C., Richland, Wash.
BRENNAN, THOMAS L., Cranford, N. J.
BRIGNER, CHARLES F., JR., Royal Oak, Mich.
BRITTON, DONALD D., Charleston, W. Va.
BRYSON, NEIL B., Toronto, Ont., Can.
BURDICK, JOHN S., New York, N. Y.
BURNHAM, MARVIN W., Fayetteville, Ark.
CAHN, GERARDO R. A., Buenos Aires, Argentina
CARNAVOS, THEODORE C., Schenectady, N. Y.
CHASTAIN, HENRY N., Brookfield, Ill.
CHEN, RICHARD J., Hongkong, China
CLARK, NORMAN D., Wellsville, N. Y.
CORDREY, RICHARD N., Toledo, Ohio
CUTINO, THOMAS P., San Francisco, Calif.
DENT, HAROLD M., Flint, Mich.
DEREAMER, RUSSELL, New York, N. Y.
DEVAN, EDWARD A., Flushing, L. I., N. Y.
DIKE, ROBERT S., Los Alamos, N. Mex.
ENGLISH, LYLE B., San Bernardino, Calif.
ERNST, JEAN J., Fond du Lac, Wis.
EVANS, JOHN B., Oreland, Pa.
EWERT, JAMES H., San Francisco, Calif.
FAIRCHILD, DENNISON, Bradford, Pa.
FEHR, ROBERT O., Schenectady, N. Y.
FLECK, CYRUS S., Easton, Pa.
FLEMING, FELIX W., Kansas City, Mo.
FLOOD, LEO P., Middle Village, N. Y.
FORSHEE, GORDON W., Washington, D. C.
GEORGE, CHARLES W., Schenectady, N. Y.
GILMAN, CHARLES B., JR., Cheshire, Conn.
GODSEY, HAROLD D., Industrial City, Mo.
GREENHILL, JEROME H., Miami Beach, Fla.
HAMMER, CHARLES F., Wilmerding, Pa.

(ASME News continued on page 388)





YARWAY Type "B" Seatless Blow-Off Valve with balanced sliding plunger. No seat to score, wear, clog or leak. For pressures to 400 psi. See Bulletin B-426. Other YARWAY Blow-Off Valves for pressures to 2500 psi. See Bulletin B-434.

THIS PRODUCTION "DOUBLE CHECK" SAFEGUARDS YOUR BOILER INVESTMENT!

■ Yes, here is one extra production step we will never bypass! It is your guarantee of a *dependable*, long-life blow-off valve.

In this corner of the YARWAY Testing Department, *every Yarway Blow-Off Valve* is hydrostatically tested at 1½ times its rated maximum working pressure—proved drop-tight for service far beyond normal expectancy.

Not only blow-off valves, but *all* YARWAY equipment undergoes rigorous tests before leaving the YARWAY plant. Why? For one reason—to assure longer and better service in *your* plant. Over 15,000 boiler plants are using YARWAY Blow-Off Valves—some for twenty-thirty years, or longer.

Whenever you are in need of boiler blow-off valves, be sure to *make Yarway your way*.

YARNALL-WARING COMPANY

100 Mermaid Avenue, Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

steam plant equipment

BLOW-OFF VALVES	DIGESTER VALVES
WATER COLUMNS AND GAGES	STEAM TRAPS
REMOTE LIQUID LEVEL INDICATORS	STRAINERS
EXPANSION JOINTS	SPRAY NOZZLES

Handsley, George H., Islington, Ont., Can.
Hanks, Roger L., Jr., Pensacola, Fla.
Hardcastle, Philip P., Tulsa, Okla.
Hedberg, Robert B., Cedar Rapids, Iowa
Herr, Harry K., Wood River, Ill.
Hess, Frederick G., Collingswood, N. J.
Hewson, Thomas A., Medfield, Mass.
Hilton, Paul F., Niagara Falls, N. Y.
Hines, Charles E., Lincoln, Neb.
Holstege, Conrad J., New York, N. Y.
Horlacher, Herman F., Philadelphia, Pa.
Hoyt, Gerald A., Schenectady, N. Y.
Hugins, Hollis N., Milford, Conn.
Humbert, Kingsley E., Woodcliff, N. J.
Jahns, William H., Newport Beach, Calif.
Jaycox, Jack M., Jr., Massillon, Ohio
Jenkins, LaVerne E., Richland, Wash.
Joslin, Richard S., Janesville, Wis.
Kahn, Eric H., New York, N. Y.
Kelly, Douglas V., Lafayette, Calif.
Kopple, Raymond E., Charleston, W. Va.
Kreipke, Sven A., Charleston, W. Va.
Krinbill, Carl A., Jr., Tlalnepantla, Mex.
Kusserow, Raymond H., Chattanooga, Tenn.
Lamb, Henry G., Bronxville, N. Y.
Lambillotte, G. John, Barberton, Ohio
Leuba, Richard J., Seattle, Wash.
Lutz, John O., Ridley Park, Pa.
Mackey, Charles T., Philadelphia, Pa.
Maggioli, George J., San Francisco, Calif.
March, Clifton J., Jacksonville, Md.
Mattucci, George A., New York, N. Y.
Maxwell, John M., Hartsville, S. C.
McCann, Dan, Inglewood, Calif.
McClain, Lawrence R., Monroe, La.
McDonald, George L., Lincoln, Neb.
McFarling, Floyd L., Albuquerque, N. Mex.
Melvin, Ralph A., Saginaw, Mich.
Mitchell, James G., Montreal, Que., Can.
Moultrie, John E., Jr., Mobile, Ala.
Munro, John F., Oakland, Calif.
Newman, Carl S., Jackson Heights, N. Y.
Paige, Rodney G., Waterford, Conn.
Painter, Robert J., Ambler, Pa.
Papaconstantinou, Stelios G., Athens, Greece
Parhomek, Pete F., Kansas City, Mo.
Philips, Frederick T., Baytown, Texas
Pier, Harry M., New York, N. Y.
Price, David S., Charleston, W. Va.
Roberts, Robert E., Severna Park, Md.
Roper, William N., Los Angeles, Calif.
Rosser, William N., Baltimore, Md.
Rosson, Barnard A., Huntsville, Ala.
Rudo, Stephen I., New York, N. Y.
Satizabal-A., Hernando, Cali, Colombia, S. A.
Schlegel, Austin C., Temple City, Calif.
Schlitzer, Henry J., Baltimore, Md.
Schoeller, V. Donald, Philadelphia, Pa.
Schulke, Robert, W, Weston, Conn.
Seiss, Richard L., Wilmington, Del.
Seth, Carl H., Baltimore, Md.
Shapcott, Ralph L., Hatboro, Pa.
Sheetz, Silas O., Charleston, W. Va.
Sleeswyk, Andre W., Cambridge, Mass.
Smith, Hadley J., Ann Arbor, Mich.
Stafford, Gilbert S., Wakefield, R. I.
Steber, John W., 3rd, Mobile, Ala.
Stewart, Willis L., Suffern, N. Y.
Stinson, Walter D., Independence, Mo.
Stockton, Charles F., Jr., Jacksonville, Fla.
Thames, Terry E., Jr., Pensacola, Fla.
Tilley, Edward N., Texas City, Texas
Tod, David B., Los Alamos, N. Mex.
Tomko, Michael, Baltimore, Md.
Tonges, Carl F., Fort Wayne, Ind.
Torloni, Armando, São Paulo, Brazil
Vild, Donald J., Cleveland, Ohio
Watts, George A., Alliance, Ohio
White, John P., Little Rock, Ark.
Wiersema, Harold L., Downey, Calif.
Wray, James Q., Jr., Towson, Md.
Wright, Harold C., Pittsburgh, Pa.
Yang, Denis C., Prospect Park, Pa.
Zeringue, Herman J., Port Sulphur, La.

Change in Grading

Transfers to Member or Affiliate

Apkarian, Harry, Schenectady, N. Y.
Austin, Richard C., Detroit, Mich.
Blake, John H., Norwood, R. I.
Boyle, Edward S., Columbia, S. C.
Burgess, Ray W., Baton Rouge, La.
Button, Lawrence N. Medway, Mass.
Cook, Frank A., Rosemont, Pa.
Deily, Arthur T., Pittsburgh, Pa.
Eggleston, John E., Pasadena, Calif.
Forhecz, Joseph A., Wood-Ridge, N. J.
Graesser, Elmer C., Wilmington, Del.
Greenwald, Daniel J., Jr., Minneapolis, Minn.
Hussander, George C., Jr., Milwaukee, Wis.
Meyers, Donald N., Philadelphia, Pa.
Neville, Garth E., Charleston, W. Va.
Nial, Walter R., Scotia, N. Y.
Rhoades, Russell H., Palo Alto, Calif.
Richards, Ernest J., Phoenix, Ariz.
Roben, Edward J., Paramus, N. J.
Scharf, Arthur, Columbus, Ohio
Sperzel, Joseph M., New York, N. Y.
Stoehr, Frederick, Sheboygan, Wis.
Szenas, Alexander A., Mt. Vernon, Ohio
Watkins, George E., New York, N. Y.
Wilhelm, Wilbur F., Jr., Long Beach, Calif.

Transfers from Student Member to Associate Member............................38

Obituaries . . .

Paul Lockwood Bartow (1902–1955), chief mechanical engineer, Florida Power Corp., died Jan. 14, 1955, in St. Petersburg, Fla. Born, Anderson, Ind., Oct. 12, 1902. Parents, Harry A. and Florence E. Bartow. Education, BS(ME), Georgia School of Technology, 1925. Married Opal Loofbourrow, 1928. Mem. ASME, 1944.

Hubert Charles Blackwell (1880–1955), retired chairman of the board, Cincinnati Gas & Electric Co., died Jan. 18, 1955. Born, Montreal, Que., Can., Feb. 22, 1880. Parents, Charles and Emily M. (Chandler) Blackwell. Education, BS Purdue University, 1902; DE, 1940. Married Robina E. Cooper, Dec. 22, 1908. He had been director, Purdue Research Foundation, Purdue University, since 1941. Survived by wife; two sons, Gordon C., Cincinnati, Hugh G., Austin, Texas; and two grandchildren.

Frederick M. Conran (1884–1954), designer and builder of special machinery, Newark, N. J., died Nov. 11, 1954. Born, Harwinton, Conn., May 5, 1884. Parents, Nicholas and Mary (Breen) Conran. Education, graduate, Torrington (Conn.) High School; ME courses, ICS. Married Mabel Callender, 1915; children, Agnes M., Frederick M., Jr., Evelyn R., Marian L. Assoc.-Mem. ASME, 1914; Mem. ASME, 1935.

Eugene Monson Farrar (1908–1954), superintendent, Light & Power, Town of Culpeper, Culpeper, Va., died June 27, 1954. Born, Roanoke, Va., Oct. 24, 1908. Education, high-school graduate; ICS courses. Jun. ASME, 1951.

Joseph Milton Farrell (1901–1954), planning engineer, Headquarters Air Training Command, Scott AFB, Belleville, Ill., died recently, according to a notice received by the Society. Born, Chapman, Kan., May 22, 1901. Parents, Thomas E. and Victoria M. (Neyer) Farrell. Education, BS(IE), University of Kansas, 1932. Married Mary J. Finger, 1941; son Joseph Michael. Assoc.-Mem. ASME, 1933; Mem. ASME, 1935.

William Robert Gibson, (1882–1954), whose death was recently reported to the Society, was owner, Northwest Filter Co., Seattle, Wash. Born, Wolstanton, Staffs., England, May 26, 1882. Education, 2 years, City of London College; 2 years, University College, London, England. Mem. ASME, 1930.

Milton Emmons Hanson (1891–1955?), whose death was reported recently to the Society, was mechanical engineer, B. F. Sturtevant Co. Division, Westinghouse Electric Corp., Camden, N. J. Born, Lewiston, Me., May 2, 1891. Parents, Charles W. and Winona M. (Worthy) Hanson. Education, 3 years, Worcester Polytechnic Institute; many technical correspondence courses. Married Dorothy Chase, 1916; children, Marcia, Barbara. He held some 40 U. S. Patents including a chlorine-gas valve, dry-ice system for cooling passenger cars, drying machinery for textiles, and rapid drying systems for four-color printing. Jun. ASME, 1919; Mem. ASME, 1927.

Robert Lansing Hardy (1929–1954), physical metallurgist, Laboratory Division, Watertown Arsenal, Watertown, Mass., died Dec. 29, 1954. Born, Newton, Mass., Nov. 22, 1929. Parents, Arthur C. and Charlotte (Lansing) Hardy. Education, BS, Massachusetts Institute of Technology, 1953; MS, 1954. Assoc.-Mem. ASME, 1954. Survived by his parents.

Sasha Sam Headman (1887–1955?), whose death was reported recently to the Society, was a partner in the firm of Headman, Ferguson & Carrollo, consulting engineers, Phoenix, Ariz. Born, San Francisco, Calif., Aug. 10, 1887. Parents, Abram and Cecilia Headman. Education, BS (Electrical), University of California, 1909. Married Kathleen Marie Shaw, 1921. Mem. ASME, 1925.

Water Freeman Hovey (1887–1955), engineer, Sanderson & Porter, New York, N. Y., died Jan. 3, 1955. Born, Beverly, N. J., Dec. 16, 1887. Parents, Franklin and Caroline V. (Freeman) Hovey. Education, graduate William Penn Charter School, 1905; BS(EE), University of Pennsylvania, 1909. Married Angelica Haigh. Mem. ASME, 1938. Survived by son, Anthony, Briarcliff, N. Y.

Thomas Edward Humphreys (1917–1955?), whose death was reported recently to the Society, was mechanical engineer, boiler and machinery department, American Motorists Insurance Co. Division, Kemper Insurance, Middletown, Conn. Born, New York, N. Y., Dec. 9, 1917. Education, graduate, Brooklyn Prep, 1937; BS (marine engineering), U. S. Merchant Marine Academy, 1942. He was a licensed chief marine and stationary engineer; commissioned boiler inspector, N. B., and N. Y. Mem. ASME, 1952.

Max Jakob (1879–1955), authority on heat transfer and thermodynamics and research professor, mechanical-engineering department, Illinois Institute of Techology, Chicago, Ill., died Jan. 4, 1955. Born, Ludwigshafen, Germany, July 20, 1879. Parents, Heinrich and Ernestine Jakob. Education, EE, Royal Institute of Technology, Munich, 1902; applied physics, 1903; DE, 1904; hon. DE, Purdue University, 1949, where he served as a consultant in heat transfer. Naturalized U. S. citizen, 1942. Married Anna Wassertruedinger, 1913. Dr. Jakob came to the United States in 1936, joined the IIT staff in 1937, and there built a heat-transfer laboratory which won world-wide recognition and attracted students from many countries. He wrote extensively on the transfer of heat in mechanics and was coauthor of an eight-volume work, "The Chemical Engineer," published in 1935. Shortly before his death he completed the manuscript for the second volume of a textbook, "Heat Transfer," originally published in 1949. He was the inventor of numerous apparatus in the field of the thermodynamics, heat transmission, and flow metering. After becoming an American citizen, he acted as consultant to the War Department during World War II; served on the Scientific Advisory Council of Picatinny Arsenal, N. J.; and as a consultant to Argonne National Laboratory of the U. S. Atomic Energy Commission. Mem. ASME, 1937. He was 1952 recipient of the ASME Worcester Reed Warner Medal. He took an active part in the affairs of the Heat Transfer Division of the Society. His memberships in technical and honorary professional societies include: AIChE, ASEE, American Society of University Professors, Sigma Xi science honorary, and Pi Tau Sigma and Rho Delta Rho fraternities. Survived by wife; daughter, Elizabeth; and son, Dr. Karl Jakob, a research geneticist in Israel.

Clarence Randolph Leach (1912–1954), sales engineer, Diamond Power Specialty Corp., New York, N. Y., died Oct. 25, 1954. Born, Brooklyn, N. Y., Feb. 25, 1912. Parents, Clarence Randolph and Susan Wright (Duryea) Leach. Education, attended Lafayette College, 1930–1932; BS (ME), University of Michigan, 1934. Married Elaine Suzanne Romeike, 1938. Jun. ASME, 1939. Survived by wife and two sons, Thomas and Michael.

Lionel Simeon Marks (1871–1955), Gordon McKay professor emeritus of mechanical engineering, Harvard University; and editor in chief of the widely used "Mechanical Engineers' Handbook," collapsed and died of a heart attack, Jan. 6, 1955, aboard a New York-bound train. He spent part of each year in Mexico and was beginning his journey south when he was stricken. Born, Birmingham, England, Sept. 8, 1871. Parents, S. E. and S. E. Marks. Education, King Edward VI School, Birmingham, England; engineering diploma, Mason College, Birmingham, 1891; BS, University of London, 1892; MME, Cornell University, 1894. The Lionel S. Marks Fellowship, recently established, will provide support for graduate study of mechanical engineering in Harvard's Division of Engineering and Applied Physics. Professor Marks came to this country in 1892 to study at Cornell on a similar fellowship—England's 1851 Exposition Fellowship. Married Josephine Preston Peabody, 1906 (died 1922). Assoc. ASME, 1897; Mem. ASME, 1904; Fellow ASME, 1939. Author of "Gas and Oil Engines," "Mechanical Engineers' Handbook" (first edition, 1916; fifth edition, 1951); coauthor with Harvey N. Davis, 1909, "Steam Tables and Diagrams"; "The Airplane Engine," 1922; "Axial-Flow Fans," 1937; and numerous technical papers. An early advocate of the combustion engine, he took part in World War I experiments directed to powering aircraft with turbines. He was national lecturer of Sigma Xi in 1942 and was the first national lecturer of ASME. Survived by daughter, Alison P., psychiatric social worker in Boston, Mass.; and son, Lionel P., New York, N. Y., attorney.

Laurence Meharg (1887–1955), consultant, Hazel-Atlas Glass Co., Wheeling, W. Va., died Jan. 4, 1955. Born, Reading, Pa., Dec. 8, 1887. Parents, John W. and Mauna J. Meharg. Education, graduate, Williamson (Pa.) School of Mechanical Trades, 1907. Married Alexa M. Hol-

(*ASME News continued on page 390*)

mann, 1914. Mem. ASME, 1942. Survived by wife.

Austin Wilbur Parker (1863–1955), retired, publicity manager, Worthington Pump and Machinery Corp., died Jan. 27, 1955, at his home in Rutherford, N. J. Born, Woburn, Mass., April 14, 1863. Parents, Josiah and Nancy (Wyman) Parker. Education, high-school graduate; short special course, Worcester Polytechnic Institute, 1885. Married Elizabeth West, 1905. Jun. ASME, 1892; Mem. ASME, 1901. Survived by wife; son, Wyman W. Parker, director of libraries, University of Cincinnati; and three grandsons.

Francis Clarence Peters (1889–1955?), whose death was reported recently to the Society, was manager of engineering, The New Jersey Zinc Co., Palmerton, Pa. Born, Aquashicola, Pa., March 24, 1889. Parents, August and Kate Peters. Education, BS(ME), Lehigh University, 1910. Married Florence Moser, 1910; daughter, Catherine. Mem. ASME, 1936; Fellow ASME, 1951. He served the Society as chairman, Anthracite-Lehigh Valley Section, 1938–1939; vice-chairman, 1939–1941.

John Arthur Rennie (1886–1954), chief mechanical engineer, Boorum & Pease Co., Brooklyn, N. Y., died March 1, 1954. Born, Oakdale, Tenn., June 9, 1886. Parents, William and Georgina Rennie. Education, Pratt Institute of Science and Technology; ME, Columbia University, 1907; postgraduate study, Columbia. Married Nancy A. Coyle, 1938; daughters, Georgina A., Beverly A. Mem. ASME, 1921. He held two patents; an aeroplane balancing apparatus and a loose-leaf binder.

Herman Adolph Blume Schwennesen (1881–1954), retired engineer of Niagara Falls, N. Y., died April 3, 1954. Born, Tonder, Denmark, July 13, 1881. Education, 4 years, mechanical engineering, University of Berlin; 1 year, economics, University of Copenhagen. Mem. ASME, 1921.

Joseph Stanley Seaman (1891–1954), president Precision Parts, Inc., New York, N. Y., died Sept. 5, 1954. Born, Nürnberg, Germany, April 25, 1891. Education, St. Handelschule, Nürnberg, 1907; ME, Ohm Polytechnikum, 1911. Mem. ASME, 1946. Survived by brother, Justin Saemann, London, England; and sister, Mrs. Bella Eberhardt, Nürnberg, Germany.

Morris Simons (1887–1954), retired president, The Union Wire Die Corp., New York, N. Y., died Nov. 19, 1954. Born, Minsk, Russia, Jan. 11, 1887. Education, graduate, Commercial Technical School, 1904; ME, Union College, Married Lucy Shapiro, 1915. Mem. ASME 1941. Survived by wife, two daughters, Hilda Kazaras, Stamford, Conn.; Norma Zucker, New York, N. Y.; and four grandchildren.

Burton Robert Snedegar (1923–1954), design engineer, Wheeling Steel Corp., Steubenville, Ohio, died Nov. 7, 1954. Born, Beard, W. Va., Dec. 20, 1923. Education, BS(ME), University of West Virginia, 1951. Jun. ASME, 1951.

Harry Herbert Rawson Spofford (1889–1954), retired, trust officer and vice-president, Boston (Mass.) Safe Deposit & Trust Co., died Dec. 28, 1954, at Newton Wellesley Hospital. Born, Hudson, Mass., July 20, 1889. Parents, Herbert E. and Annie Mabel (Rawson) Spofford. Education, BS, Harvard College, 1911; Graduate School of Applied Science, 1912; graduate, U. S. Naval Academy's Fourth Reserve Officers' Class in 1916. He was commissioned Ensign, USN, and assigned to foreign service as engineering officer on USS *Mercury*, 1918-1919. Married Hildur Emelia Dahl, 1922. Jun. ASME, 1915; Mem. ASME, 1922. Survived by wife; daughter, Mrs. Vernon Hall, Westboro, Mass; son, John Eliot Spofford, Pfc, USA Medical Service in Korea; two brothers, George R., Berlin, Mass.; Walter R., Chicago, Ill.; and sister, M. Ethelyn Spofford, Hudson, Mass.

Arthur Eugene Steele (1919–1955?), whose death was reported recently to the Society, was sales engineer, James B. Clow and Sons. Born, Auburn, Ala., Aug. 12, 1919. Education, BS, Alabama Polytechnic Institute, 1940. Jun. ASME, 1952.

Sylvan Van Vlerah (1898–1954), assistant supervising engineer, Board of Education, City of Detroit (Mich.), died Oct. 14, 1954. Born, Pleasant Bend, Ohio, Nov. 28, 1898. Education, BS(ME), University of Michigan, 1925. Mem. ASME, 1939.

Francis Albert White (1877–1954), sales engineer, John Inglis Co., Toronto, Ont., Can., died in November, 1954. Born, Cambridge, Gloucestershire, England, Feb. 1, 1877. Education, graduate, Stroud Technical School. Mem. ASME, 1918.

James Forbes Whiteford (1876–1954), retired engineer of San Diego, Calif., died Dec. 13, 1954. Born, Pittston, Pa., May 16, 1876. Education, high-school graduate. Mem. ASME, 1908.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions' enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting this information is printed on this page. Please use it to keep the master file up to date.

ASME Master-File Information

(Not for use of student members)

Please print **Check mailing address**

Name...
Last First Middle

Home address...☐
Street City Zone State

Name of employer...

Address of employer..☐
Street City Zone State

Product or service of company..

Title of position held...

Nature of work done..

I am a subscriber to (please check)

Publication	*Address changes effective when received prior to:*
☐ Mechanical Engineering	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

Please register me in three Professional Divisions as checked:

☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ T—Textile
☐ C—Management	☐ L—Process Industries	☐ V—Gas Turbine Power
☐ D—Materials Handling	☐ M—Production Engineering	☐ W—Wood Industries
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ Y—Rubber and Plastics
☐ F—Fuels	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ G—Safety	☐ Q—Nuclear Engineering	
☐ H—Hydraulics	☐ R—Railroad	

grad-
Poly-
abeth
SME,
rker,
nati;

vhose
was
Zinc
Pa.,
Kate
rsity,
ghter,
SME,
An-
vice-

me-
klyn,
kdale,
and
te of
niver-
Mar-
rgina
held
ratus

1881–
I. Y.,
mark,
anical
nom-
SME,

sident
died
April
Nürn-
1911.
Justin
Mrs.

dent,
N. Y.,
Jan.
ercial
ollege,
ASME
Hilda
New

design
nville,
. Va.,
ersity

1954),
Boston
ec. 28,
Born,
erbert
Educa-
School
Naval
ss in
I, and
officer
Hildur
Mem.
, Mrs.
Eliot
Korea;
Walter
offord.

whose
y, was
Born,
, BS,
Jun.

nt su-
of De-
easant
(ME),
SME,

es en-
., died
ouces-
cation,
Mem.

etired.
, 1954.
cation,
.

mann, 1914. Mem. ASME, 1942. Survived by wife.

Austin Wilbur Parker (1863–1955), retired, publicity manager, Worthington Pump and Machinery Corp., died Jan. 27, 1955, at his home in Rutherford, N. J. Born, Woburn, Mass., April 14, 1863. Parents, Josiah and Nancy (Wyman) Parker. Education, high-school graduate; short special course, Worcester Polytechnic Institute, 1885. Married Elizabeth West, 1905. Jun. ASME, 1892; Mem. ASME, 1901. Survived by wife; son, Wyman W. Parker, director of libraries, University of Cincinnati; and three grandsons.

Francis Clarence Peters (1889–1955?), whose death was reported recently to the Society, was manager of engineering, The New Jersey Zinc Co., Palmerton, Pa. Born, Aquashicola, Pa., March 24, 1889. Parents, August and Kate Peters. Education, BS(ME), Lehigh University, 1910. Married Florence Moser, 1910; daughter, Catherine. Mem. ASME, 1936; Fellow ASME, 1951. He served the Society as chairman, Anthracite-Lehigh Valley Section, 1938–1939; vice-chairman, 1939–1941.

John Arthur Rennie (1886–1954), chief mechanical engineer, Boorum & Pease Co., Brooklyn, N. Y., died March 1, 1954. Born, Oakdale, Tenn., June 9, 1886. Parents, William and Georgina Rennie. Education, Pratt Institute of Science and Technology; ME, Columbia University, 1907; postgraduate study, Columbia. Married Nancy A. Coyle, 1938; daughters, Georgina A., Beverly A. Mem. ASME, 1921. He held two patents; an aeroplane balancing apparatus and a loose-leaf binder.

Herman Adolph Blume Schwennesen (1881–1954), retired engineer of Niagara Falls, N. Y., died April 3, 1954. Born, Tonder, Denmark, July 13, 1881. Education, 4 years, mechanical engineering, University of Berlin; 1 year, economics, University of Copenhagen. Mem. ASME, 1921.

Joseph Stanley Seaman (1891–1954), president Precision Parts, Inc., New York, N. Y., died Sept. 5, 1954. Born, Nürnberg, Germany, April 25, 1891. Education, St. Handelschule, Nürnberg, 1907; ME, Ohm Polytechnikum, 1911. Mem. ASME, 1946. Survived by brother, Justin Saemann, London, England; and sister, Mrs. Bella Eberhardt, Nürnberg, Germany.

Morris Simons (1887–1954), retired president, The Union Wire Die Corp., New York, N. Y., died Nov. 19, 1954. Born, Minsk, Russia, Jan. 11, 1887. Education, graduate, Commercial Technical School, 1904; ME, Union College, Married Lucy Shapiro, 1915. Mem. ASME 1941. Survived by wife, two daughters, Hilda Kazaras, Stamford, Conn.; Norma Zucker, New York, N. Y.; and four grandchildren.

Burton Robert Snedegar (1923–1954), design engineer, Wheeling Steel Corp., Steubenville, Ohio, died Nov. 7, 1954. Born, Beard, W. Va., Dec. 20, 1923. Education, BS(ME), University of West Virginia, 1951. Jun. ASME, 1951.

Harry Herbert Rawson Spofford (1889–1954), retired, trust officer and vice-president, Boston (Mass.) Safe Deposit & Trust Co., died Dec. 28, 1954, at Newton Wellesley Hospital. Born, Hudson, Mass., July 20, 1889. Parents, Herbert E. and Annie Mabel (Rawson) Spofford. Education, BS, Harvard College, 1911; Graduate School of Applied Science, 1912; graduate, U. S. Naval Academy's Fourth Reserve Officers' Class in 1916. He was commissioned Ensign, USN, and assigned to foreign service as engineering officer on USS *Mercury*, 1918-1919. Married Hildur Emelia Dahl, 1922. Jun. ASME, 1915; Mem. ASME, 1922. Survived by wife; daughter, Mrs. Vernon Hall, Westboro, Mass; son, John Eliot Spofford, Pfc, USA Medical Service in Korea; two brothers, George R., Berlin, Mass.; Walter R., Chicago, Ill.; and sister, M. Ethelyn Spofford, Hudson, Mass.

Arthur Eugene Steele (1919–1955?), whose death was reported recently to the Society, was sales engineer, James B. Clow and Sons. Born, Auburn, Ala., Aug. 12, 1919. Education, BS, Alabama Polytechnic Institute, 1940. Jun. ASME, 1952.

Sylvan Van Vlerah (1898–1954), assistant supervising engineer, Board of Education, City of Detroit (Mich.), died Oct. 14, 1954. Born, Pleasant Bend, Ohio, Nov. 28, 1898. Education, BS(ME), University of Michigan, 1925. Mem. ASME, 1939.

Francis Albert White (1877–1954), sales engineer, John Inglis Co., Toronto, Ont., Can., died in November, 1954. Born, Cambridge, Gloucestershire, England, Feb. 1, 1877. Education, graduate, Stroud Technical School. Mem. ASME, 1918.

James Forbes Whiteford (1876–1954), retired. engineer of San Diego, Calif., died Dec. 13, 1954. Born, Pittston, Pa., May 16, 1876. Education, high-school graduate. Mem. ASME, 1908.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions' enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting this information is printed on this page. Please use it to keep the master file up to date.

ASME Master-File Information

(Not for use of student members)

Please print **Check mailing address**

Name..
Last First Middle

Home address.. ☐
Street City Zone State

Name of employer..

Address of employer... ☐
Street City Zone State

Product or service of company...

Title of position held..

Nature of work done...

I am a subscriber to (please check)

Publication	*Address changes effective when received prior to:*
☐ Mechanical Engineering	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

Please register me in three Professional Divisions as checked:

☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ T—Textile
☐ C—Management	☐ L—Process Industries	☐ V—Gas Turbine Power
☐ D—Materials Handling	☐ M—Production Engineering	☐ W—Wood Industries
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ Y—Rubber and Plastics
☐ F—Fuels	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ G—Safety	☐ Q—Nuclear Engineering	
☐ H—Hydraulics	☐ R—Railroad	